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ABSTRACT

Three separate, sequential three-month studies were made to determine the effects of timed pupil feedback on teaching behavior. Audiotapes were made of the teaching behaviors of eighteen teachers before, during, and after the teachers introduced a feedback instrument to their pupils. The tapes were analyzed for changes in teacher behavior over the period of time the feedback was used. The results indicated that student feedback did change the teaching behavior significantly. The general direction of change was toward less teacher talk and lecture. The questioning techniques of teachers stayed fairly constant with the only statistically significant change being in the mean number of questions asked each month. The conclusions were that students can give accurate feedback which effects change in teacher behavior and that this change can be described and quantified using interaction analysis techniques. (Author/JY)

FINAL REPORT

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A STUDY OF THE EFFECTS OF THE USE OF A PUPIL RESPONSE INSTRUMENT ON THE BEHAVIORS OF BIOLOGICAL SCIENCE TEACHERS

NOVEMBER, 1972

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

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ABSTRACT

Eighteen teachers participated in three separate, sequential three-month groups in a study to determine the effects of timed pupil feedback on teaching behavior. Audio tapes were made of the teaching behaviors before, during and after the teachers introduced the feedback instrument to the pupils. These audio tapes were transcribed using the Parakh Interaction Analysis System and the Gallagher Aschner Questioning Category System as modified by Alan K. Kondo. These transcriptions were then treated and tested for statistically significant differences in the per cent of teacher talk, the per cent of teacher time spent in different teaching modes as described by the Moser Six Set System, and for changes in questioning techniques. Finally student ratings were compiled and tested for significant difference in number ratings which were positive in nature over the period of time the feedback was used.

The results of the statistical tests indicate that student feedback did change the teaching behavior significantly. The general direction of change is toward less teacher talk and lecture. The questioning techniques of teachers stayed fairly constant with the only statistically significant change being in the mean number of questions asked each month. A comparison of student feedback showed statistically significant change in the direction of more

positive ratings of the teachers.

The conclusions are that students can give accurate feedback. This feedback does effect change in teacher behavior. Finally, this change can be described and quantified using interaction analysis techniques.

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U.S. DEPARTMENT OF
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Office of Education
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TABLE OF CONTENTS

Page

Introduction.....1

I. Method of Research.....4

A. Statement of the Problem.....4
B. Delimitations.....4
C. Limitations.....5
D. Hypotheses.....6
E. Collection and Treatment of Data.....8
F. Procedure.....11

II. Background and Related Literature.....16

III. The Data and Findings.....26

IV. Summary and Recommendations.....70

Appendices.....78

Bibliography.....108

Page

Table 10 The Number of Divergent Questions Asked Per Lesson Per Month for Each Teacher Participating in the Study.....48

Table 11 The Mean Percentages of Thought-Type Questions Asked by Each Teacher over the Combined Three Month Period of the Study Tested for Statistical Significance Using a Two-way Analysis of Variance.....49

Table 12 The Mean Percentages of Student Questions Asked Over the Combined Three Month Period of the Study Tested for Statistical Significance Using a Two-way Analysis of Variance.....51

Table 13 Chi Square Tests of Significant Difference in the Per Cent of Inquiry-oriented Classroom Activities as Reported by the Teachers on their Time Logs.....56

Table 14 Correlation of Teacher Score on the Kochendorfer Science Activities Checklist With the Per Cent of the Mode of Teaching as Indicated by the Six Set.....59

Table 15 Cumulative Frequencies and Per Cent of Total Pupil Responses for All Teachers.....66

Table 16 Chi Square Tests of Significance of Change in the Number of Ratings in Student Rating Sheets.....69

LIST OF ILLUSTRATIONS

Page

Figure I The Mean Per Cent of Teacher Talk for the Combined Three Months of the Experiment for All Teachers.....28

Figure II The Mean Per Cent of Lecture for the Combined Three Months of the Experiment for All Teachers.....33

Figure III Slopes and Intercepts of the Correlation of the Per Cent of Student Response of "Good" with the Per Cent of Teacher Lecture During the Same Time Period.....35

Figure IV Slopes and Intercepts of the Correlation of the Per Cent of the Student Response of "Understand" with the Amount of Teacher Lecture During the Same Time Period...36

Figure V Slopes and Intercepts of the Correlation of the Per Cent of the Student Response of "Good" with the Per Cent of Class Discussion During the Same Time Period.....40

Figure VI Slopes and Intercepts for the Correlation of Per Cent of the Per Cent of Student Response of "Understand" with the Per Cent of Class Discussion During the Same Time Period.....41

Figure VII Slopes and Intercepts for the Correlation of the Per Cent of Student Response of "Good" with the Per Cent of Transition Occurring During the Same Time Period.....43

Figure VIII Slopes and Intercepts for the Correlation of the Per Cent of Student Response of "Understand" with the Per Cent of Transition Occurring During the Same Time Period.....44

Figure IX Individual Scores Given by Pupils to Teachers on the Kochendorfer Science Activities Checklist.....52

Page

Figure X Comparing the Teacher Logs for the Three that Each Teacher Participated in the Study for the Per Cent of Inquiry-Oriented Activities.....53

Figure XI Overall Ratio of Positive Student Responses to Negative Student Responses Given to All Teachers During the Sequence of Rating Sheets Given to Teachers During the Treatment Month.....60

Figure XII Per Cent of Total Student Response to "Good" During the Sequence of Rating Sheets Given to Teachers During the Treatment Month..62

Figure XIII Overall Ratio of the Student Response of "Interested" over the Student Response of "Bored" given to teachers During the Sequence of Rating Sheets Given During the Treatment Month.....63

Figure XIV Overall Ratio of the Student Response of "Understand" over the Student Response of "Don't Understand" Given to Teachers During the Sequence of Rating Sheets Given During the Treatment Month.....64

Figure XV Percentage of Total Responses Made During All the Lessons for All the Teachers.....67

INTRODUCTION

Studies on ways to modify teaching behavior have, in the past, centered mainly on the role of supervisors, administrators or various expert clinicians. These studies have tried to answer questions such as how a supervisor or administrator can best "relate" to the teacher in order to have the teacher move toward more "positive" teaching behavior. The criteria for this positive behavior has been established by the administrator or supervisor himself. Occasionally evaluation committees have used pupil opinion, but unfortunately this was not used as a learning device for the teacher, but rather used as an information source for the committee.

More recently, the means of changing a teacher's verbal behavior has been simply to make the teacher more aware of his verbal behavior. This awareness was accomplished by teaching him or his supervisor one of a variety of methods of interaction analysis that have been developed during the past 20 years. Clinicians have trained teachers and supervisors in these various interaction analysis techniques and have pointed to results that show that the teacher became more aware of his verbal behavior and changed his verbal patterns to those which were more desirable according to criteria set by the supervisor or researcher. However,

Jackson points out that the results of these interaction analysis studies showed that these new behaviors did not improve a teacher's recognition of the ever-changing situational demands originating from the pupils themselves.[1]

Susan S. Klein further stated that:

> Despite recognition of the importance of studying classroom interactions, little attention has been focused upon student contributions to teaching behavior.[2]

In past studies, pupils have demonstrated that they can be used as reliable, accurate and conscientious raters of teaching behavior. Researchers that have used students as raters of teachers have found them to be as good as any other means of rating teachers. It can also be shown that from year to year, different students of the same teacher have given the same general ratings of teacher effectiveness, despite their differences in sex, age, grade received, or year graduated.

It can also be demonstrated in past research that pupil ratings do have a positive affect on teacher behavior, no matter how unorthodox the approach may be or infrequent the intervals the ratings are given to the teacher. These positive behaviors are those described by the people most affected by them . . . the teacher's pupils.

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[1]Philip W. Jackson, Life in Classrooms, New York: Holt, Rinehart and Winston, 1968.

[2]Susan S. Klein, "Student Influence on Teacher Behavior," American Educational Research Journal, Vol. 8, No. 3, May, 1971, p. 403.

It is therefore the purpose of this study to show whether a timed, sequential pupil rating sheet that is both easy to administer and not distracting to either teacher or student can convey enough information to affect modification in the teaching behavior of that teacher.

If these modifications do occur and they can be described utilizing the techniques of interaction analysis, then we, as educators, should realize and utilize the greatest classroom resource available to us for the training of present and future teachers, the students themselves.

I. METHOD OF RESEARCH

A. Statement of the Problem

This study will attempt to show the effects a timed pupil feedback instrument (see Appendix A) has on the observed classroom behavior of biological science teachers. This study further hopes to identify and describe these behavior changes by utilizing two modified forms of interaction analysis as described by Jal S. Parakh and Alan K. Kondo.[1,2]

B. Delimitations

During the 1971-72 school year, three groups of teachers participated in the study. Each group participating for three months. The teachers were selected from four different high schools in Allegheny County, located in Southwestern Pennsylvania. Allegheny County includes the city of Pittsburgh and the surrounding suburbs.

The schools were chosen first on the basis of being representative of the public school system found in the county and second on their willingness to cooperate in the

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[1]Jal S. Parakh, "A Study of Teacher-Pupil Interaction in High School Biology Classes," Unpublished doctoral dissertation, Cornell University, Ithica, New York, 1965.

[2]Alan K. Kondo, "The Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching," Presented at the NARST meeting, Pasadena, California, Feb. 7, 1969.

study. Two of the four schools participating are part of the public school system of the city of Pittsburgh, one with a predominantly lower socio-economic population and one with a largely upper-middle-class population. The remaining two schools are from two suburban communities, one with a largely middle-class population. The other, located in an upper socio-economic area, draws from both lower-middle and upper class areas.

The eighteen teachers and their students who cooperated in the study were from tenth grade general biology classes. The teachers cooperating in the study were given instructions only on how to use the instrument, and were given no instruction on how to react to student assessments. In fact, the researcher explained the response instrument to the teachers only at the beginning of the use of the response sheets. All behavior analyzed is delimited to that verbal behavior as transcribed using systems of interaction analysis as developed by Parakh and Gallagher Aschner from audio tapes taken at random intervals during the classes participating in the study.[1,2]

C. Limitations

This study is limited by the scope of the timed pupil-written feedback and the willingness and ability of the teacher to vary his teaching behavior. It is further

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[1]Parakh, Op. Cit.

[2]Kondo, Op. Cit.

limited by external influences that beleaguer all field studies: influences such as time schedules of classes, holidays, school disruptions, class disruptions, student and teacher cooperation, weather, and illness. Finally, the study is limited to the number of teachers that it was possible for one researcher to adequately study.

D. Hypotheses

HO_1 There will be no statistically significant difference in the mean monthly per cent of teacher talk over the three months of the study.

HO_2 There will be no statistically significant difference in the mean monthly per cent of lecture (as defined by the six set model) for the teachers as individuals over the three month period of the study.[1]

HO_3 There will be no statistically significant difference in the mean monthly per cent of lecture (as defined by the six set model) for the teachers as a group over the three month period of the study.[2]

HO_4 There will be no statistically significant difference in the mean monthly per cent of inquiry (as defined by the six set model) for the teachers over the three month period of the study.[3]

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[1]Gene W. Moser and Roberta Feldgoise, "Project in the Use of Interaction Analysis to Increase the Use of the Inquiry Method in the Teaching of Science," Science Project Center Report, April, 1968.

[2]Ibid.

[3]Ibid.

HO_5 There will be no statistically significant difference in the number of non-routine questions (as defined by Alan K. Kondo) asked by the teachers over the three months of the study.[1]

HO_6 There will be no statistically significant difference in the number of divergent questions (as defined by Alan K. Kondo) asked by the teachers over the three month period of the study.[2]

HO_7 There will be no statistically significant difference in the number of thought questions (all those questions not of cognitive memory or routine classification as defined by Alan K. Kondo) asked by the teachers over the three months of the study.[3]

HO_8 There will be no statistically significant difference in the number of pupil questions asked by pupils over the three months of the study.

HO_9 There will be no difference in the per cent of teacher activity identified as inquiry-oriented (as defined by the teacher logs and the Kochendorfer Checklist) during the class period over the three months of the study.[4]

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[1]Kondo, Op. Cit.

[2]Ibid.

[3]Ibid.

[4]Leonard H. Kochendorfer, "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology," University of Texas, Austin, Texas, 1969.

E. Collection and Treatment of Data

Nine audio tapes were chosen from the 24 recorded for each teacher who participated in the study. These nine tapes, three from each month, were first transcribed using a modified version of interaction analysis as designed by Jal. S. Parakh.[1] The transcriber maintained one Parakh code every four seconds. The tapes were again transcribed, this time using the Gallagher-Aschner Questioning Category System as modified by Alan K. Kondo.[2] Each teacher question that occurred during the middle half hour of each lesson was classified and enumerated. Both coding techniques were checked for intra-and-inter-observer reliability using Scott's Coefficient.[3] The results are reported in Appendix K.

The first analysis of the Parakh codes was performed by counting the total codes per lesson and determining the percentage of teacher codes in the total. These were then tested for statistically significant differences over the three months of the study, by using a two way analysis of variance.[4]

The Parakh monogram codes (see Appendix B) for each teacher for each lesson were then placed in a six set matrix

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[1]Parakh, Op. Cit.

[2]Kondo, Op. Cit.

[3]W.A. Scott, "Reliability of Content Analysis: The Case of Nominal Coding," Public Opinion Quarterly, Vol. XIX, No. 3, 1955, pp. 321-325.

[4]Ann Hughes and Dennis Grawoig, Statistics: A Foundation for Analysis, Reading, Massachusetts: Addison-Wesley Publishing Company, 1971

outlined by Moser and Feldgoise.[1] The mean percentages of entries for each month in the lecture, discussion, inquiry and transition quadrants (as defined by Moser) were computed and compared over the three month period for statistically significant differences for individual teachers using a chi-square "goodness-of-fit" test.[2] The data from teachers as a group was then tested for statistically significant differences in the teacher's mean per cent of lecture and inquiry over the three months of the study by using a two way analysis of variance.[3]

The number of questions asked by each teacher during the middle half hour of his lesson selected for each month of the study was computed and compared for statistically significant differences over the three months of the study, using a two way analysis of variance.[4] The same procedures were performed on the number of thought questions and the number of divergent questions (as defined by Kondo).[5]

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[1]Moser, Op. Cit.

[2]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences, New York: McGraw Hill Book Company, 1956, pp. 63-67.

[3]Ann Hughes and Dennis Grawoig, Statistics: A Foundation for Analysis, Reading, Mass: Addison-Wesley Publishing Company, 1971.

[4]Ibid.

[5]Kondo, Op. Cit.

The student reaction forms were collected by the teacher at the end of each class period. After the teacher had adequate time to read them, if he wished, they were collected by the researcher and a grand total for all forms for all categories was computed for each time segment of the class recorded, (after ten minutes of the lesson had lapsed, twenty minutes, etc.) and graphically compared and illustrated. The totals of student reactions for each category for the middle ten and the middle thirty minutes of the lesson given during the second month of the study were compared to the six set analysis of that same time segment of that same lesson, and then statistically tested using a coefficient of correlation and regression analysis as outlined by Simpson, Roe and Lewontin.[1] The comparisons were made between per cent of lecture, discussion and transfer (as defined by Six Set Analysis) for the per cent of students responding to each of the seven possible student ratings (Too Fast, Too Slow, Interested, Bored, Understand, Don't Understand, Good) for that same middle ten-and thirty-minute time period.[2]

Using the same general techniques as above, the digram codes of the Parakh (see Appendix B) were re-examined and the numbers of pupil question codes were totalled for

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[1] George Gaylord Simpson, Ann Roe and Richard C. Lewontin, Quantitative Zoology, New York: Harcourt, Brace and Company, 1960, p. 440.

[2] Moser, Op. Cit.

that same middle twenty minutes and compared to the percentages of student response to each category of the rating sheet. A further examination of the Parakh codes was performed and the number of teacher question codes were tallied, and these were then compared to each rating category of student response as in the previous analysis.

Each student from each of the 18 experimental classes completed a Kochendorfer Science Activities Checklist for his respective teacher at the completion of the study.[1] According to Kochendorfer, the scores on the checklist indicate the degree to which a student believes his teacher has his lessons directed towards the goals of an inquiry-based biology course. These scores were then compared to the log each teacher was to keep on his activities each week.[2]

F. Procedure

Eighteen tenth-grade biological science teachers were chosen from four high schools within Allegheny County during the 1971-72 school year. For each of the teachers and their pupils taking part in the study, the following

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[1] Leonard H. Kochendorfer, "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology," University of Texas, Austin, Texas, 1969.

[2] Ibid.

preliminary data were gathered:

TABLE 1

PRELIMINARY DATA GATHERED FOR EACH OF THE 18 TEACHERS AND THEIR CLASSES PARTICIPATING IN THE STUDY

Pupils	Teachers
(1) age	(1) age
(2) grade level	(2) school where presently teaching
(3) I.Q.	(3) school graduated from
(4) socio-economic group	(4) sex
(5) school attending	(5) years experience teaching
	(6) years experience teaching subject
	(7) number of credit hours in teaching field

Three groups of teachers were used in the study. Each group participated for three months. Nine of the 18 teachers were chosen in October, seven from city high school A and two from city high school B. These teachers were designated as Group I. The following description of the procedures for that group would apply to those for the other two groups in their respective time periods.

Two audio tapes per week of one class of each of the nine teachers were made. The class period chosen for each teacher was the only class for that teacher used throughout the study. The time of the taping was randomly chosen. Taping the classes in October established a base line of teaching behavior. At the end of each week in October, the teachers were asked to fill out a time questionnaire (see Appendix J). The instructions given the teacher were as follows:

> At the completion of each week please fill out the time sheet for that week for the experimental class period. You are to place in the proper square the per cent of activity of that type participated in during the preceding week. For example, if 25% of the time for the experimental class was spent with the entire pupil population doing the same labs as individuals, then place a "25" in block "A". If during that same week 10% of the time was spent with pupils in small groups doing different labs, then place a "10" in block"D". If 30% of the classroom time was spent with the teacher talking to the entire group of pupils, then place a "30" in block "C". Suppose another 25% of class time was spent with pupils working as individuals (Independent Study). Then place a "25" in block "H". Let us further suppose that the remaining 5% of the time was spent with the teacher leading various small group discussions. Therefore, a "5" would be placed in block "F".

The completed time questionnaire appears at the bottom of Appendix J. The teacher was also provided with a line marked "Other" in order to write in any other activity not covered in the chart.

In November, in addition to continued audio taping, the cooperating teacher was asked to pass out to his pupils the timed pupil rating sheet (see Appendix A) and give his pupils these instructions:

> "I want you to help me to help you learn biology. The sheet of paper you have on the desk in front of you is a means for you to tell me how I did today in trying to teach you biology. You will notice that the blocks from left to right are marked with comments and at the end of the blocks is a line with numbers ranging from 10 to 50. What you are to do is, if at the end of ten minutes you think I was going too fast, you check "Too Fast". If I was boring you, check "Boring". If it was interesting, check "Interesting", etc. If you wish to say something else, just write it on the line provided. Then the next time you check will be at the end of the next ten minutes (or 20 minutes after the lesson started), continuing in ten minute intervals all the way to the

> end of the lesson. If you forget or are too busy to check the clock, just skip over that time period and check when you have time, but do it in the appropriate time line. For example, it is now 12:00. If the next time you think to check the sheet is 12:20, check the 20 minute line, not the 12:10 line."

The teacher continued to explain these directions until he was satisfied that he was understood. He then gave the planned lesson for the day and collected the sheets at the end of the period. If he found that the students did not follow instructions, he went over the instructions again the next day.

The teacher was asked to use the rating sheets at least two times per week the first three weeks of November. He was then asked to review the feedback written by his pupils on the sheets given him at the end of each class to see how his lesson proceeded. The cooperating teacher was also urged to respond to the sheets in a manner with behavior that reflected the student's suggestions. The teachers were again asked to fill out the time questionnaire at the end of each week. The pupils, at the end of October, were asked to complete the Kochendorfer Science Activity Checklist (see Appendix D) for a check on those activities which have been described as characteristic of an inquiry-oriented classroom.[1]

In order to analyze the teacher's behavior and behavior change, if any, a sample of six of the total number of audio tapes taken during the months of October and Novem-

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[1]Kochendorfer, Op. Cit.

ber (three from the month of October and three from November) were chosen for each teacher and analyzed as outlined in the section on Analysis of Data. During the month of December, the nine teachers were asked not to use the pupil feedback form. Audio taping of the classes continued and three audio tapes from December were chosen for analysis.

In January of the 1971-72 school year, six new teachers were selected from suburban high school C and designated as Group II. The same procedure outlined for teachers in Group I for October and November was performed January and February for the six new biology teachers. During March, the same procedure for the second group of teachers prevailed as it did in December for the first group. Three tapes were chosen for each teacher and analyzed as outlined in the section on Analysis of Data.

In March, the third and final group consisted of three newly selected teachers. They, in March and April, ran the same procedures as the two previous groups did in October and November for Group I, and January and February for Group II. During May, Group III ran the same procedures that Group II did during March. The data analysis was the same in each group and, at the close of the study, the three groups were compared to each other for statistically significant differences as outlined in Section VII. An outline of the procedures followed is provided in Appendix C.

II. BACKGROUND AND RELATED LITERATURE

A review of research concerning teacher effectiveness points out that an awareness of student needs on the part of the teacher is indicative of effective teaching. In order to improve this teacher awareness, studies have previously centered on the input of people or things other than the pupils themselves. Various supervisory techniques as well as a myriad of interaction analysis techniques that describe the verbal behaviors of teachers quite efficiently have been used for motivators of change toward more pupil awareness.

Much of the literature concerning student rating of teacher behavior states that student ratings are as accurate as any other means of rating desirable teaching behavior. It is further shown, in a search through the literature, that teachers will react positively to student ratings no matter how they are presented. It would then seem logical that if we are to make our teachers more aware of student needs, that the motivator for this change should be those who are most affected by these changes - the pupils.

Grace E. Bird, as early as 1917, tried to describe effective teaching by using feedback given by pupils.[1] The children were asked to write a description of their favorite

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[1]Grace E. Bird, "Pupils Estimate of Teachers," Journal of Educational Psychology, Vol. 8, 1917, pp. 35-40.

teacher, explaining why this teacher was their favorite. Her findings indicated that pupils favored teachers who were most responsive to their immediate needs. Coats, using the Teacher Image Questionnaire, which was prepared by the Educator Feedback Center at Western Michigan University, points out that the item which seemed to influence a teacher's rating to the greatest extent was whether or not the students liked the teacher.[1] Gage and Suci, in 1951, found a positive relationship between how accurately teachers perceived their students' attitudes and how favorably teachers were rated by their students.[2]

Recognizing the need to improve student awareness on the part of the teacher, Jackson set out to study how teachers became aware of certain situational demands that dictated changing their teaching strategies.[3] The results showed that the teacher relied primarily on rather subtle behaviors, such as how the pupils were sitting, the expressions on the pupils' faces, and pupil responses to questions. Schueler and Gold, while studying areas needing improvement in student teaching programs, were impressed with the need for an

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[1]William D. Coats, "Students Perceptions of Teachers - A Factor Analytic Study," American Educational Research Association, Washington, D.C., Paper delivered at A.E.R.A., Minneapolis, Minnesota, March, 1970, pp. 1-15.

[2]N.L. Gage and G.J. Suci, "Social Perception and Teacher Pupil Relationships," Journal of Educational Psychology, Vol. 42, 1951, pp. 144-152.

[3]Philip W. Jackson, Life in Classrooms, New York: Holt, Rinehart and Winston, 1968.

objective instrument which would describe the actions of pupils and teachers in a science classroom.[1] They felt they could then ascertain what behavioral changes were due to student feedback, and they felt that such a device would enable them to describe the variance of ratings between individual teachers.

Men such as Flanders and Parakh have stated that the teacher's verbal actions can be used to gauge what is happening in a classroom.[2,3] McLeod, of Cornell University, trying to make teachers devote less class time to lecturing, found that the study of interaction analysis made teachers more aware of their verbal behavior.[4] Fuller, of the University of Texas at Austin, pointed out that training in the Flanders' System helped improve student-teacher

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[1]H. Schueler and M.J. Gold, "Video Recordings of Student Teachers - A Report of the Hunter College Research Project Evaluating the Use of Kinescopes in Preparing Student Teachers," The Journal of Teacher Education, Vol. 15, 1964, pp. 358-364.

[2]Ned A. Flanders, "Interaction Analysis and Inservice Training, Research and Development Toward the Improvement of Education," Edited by Klaismier and O'Hearn, Journal of Experimental Education, Vol. 37, Fall, 1968, pp. 126-133.

[3]Jal S. Parakh, "A Study of Teacher-Pupil Interaction in High School Biology Classes," Unpublished doctoral dissertation, Cornell University, Ithica, New York, 1965.

[4]R.J. McLeod, "Changes in the Verbal Interaction Patterns of Secondary Science Student Teachers Who Have Had Training in Interaction Analysis and Relationship of These Changes to the Verbal Interaction of their Cooperating Teachers," Cornell University, 1967, U.S. Dept. H.E.W., O.E., 1967.

student inter-personal behavior.[1] Waimon and Hermanowicz found that an awareness of verbal behavior caused teachers to improve their verbal interaction with students.[2] Ishler used Withall's system to rate change from teacher-centered to learner-centered teaching. He found that student teachers who were given a weekly feedback of their rating scale, changed toward more learner-centered instruction.[3]

There are presently over 80 systems of interaction analysis as can be seen in a review of behavioral literature. Many can be used to effectively describe a particular area of behavior unique to any situation. Jal S. Parakh developed a system which is particularly suitable for biology classrooms.[4] Another applicable method is the Aschner-Gallagher system of classifying thought processes.[5] Kondo used a modified version of this system in his study of the questioning behavior of elementary science teachers. It should be noted that

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[1]Frances Fuller, "Mechanical Aids to Quantification of Interpersonal Behavior (Student Teacher and Student)," Dissertation Abstract, University of Texas, Austin, Texas.

[2]M.D. Waimon and H.J. Hermanowicz, "Helping Prospective Teachers Classify and Study Teaching Behavior," The Teachers College Journal, Vol. 38, No. 3, December, 1966, pp. 97-102.

[3]R.E. Ishler, "An Experimental Study Using Withall's Social Emotional Climate Index to Determine the Effectiveness of Feedback as a Means of Changing Student Teachers' Verbal Behavior," The Journal of Educational Research, Vol. 6, No. 3, 1967.

[4]Parakh, Op. Cit.

[5]Alan K. Kondo, "The Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching," Presented at the NARST meeting, Pasadena, California, February 7, 1969.

in most of these interaction analysis studies, the teaching behavior was modified and described. However, modification was usually in terms of criteria established by supervisors or investigators. Pupils were seldom used as a source for producing the change in the verbal behavior of teachers.

A lack of pupil awareness on the part of student teachers as well as supervisors was pointed out by Jalbert. His study was aimed at the training of student teachers and their supervisors in the use of interaction analysis.[1] At the study's conclusion, student teachers were found to be more aware of their verbal behavior. However, it was also found that "the training helped least in concern for children", and that teacher awareness of pupil needs was not measureably improved.[2] If the teacher is to become aware of the interaction between teachers and students and react to situational demands, it would seem logical to utilize the pupils as the motivating force of change as well as the judges of the quality of change.

Kellough and Murdock (in separate studies) emphasized the need for pupil ratings of teachers and the effects which

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[1]E.L. Jalbert and Elizabeth Lynch, "The Effectiveness of Training in the Evaluation of Classroom Instruction as an Aid to Self-evaluation in StudentTeaching," The Journal of Educational Research, Vol. 60, No. 3, November 1966, pp. 130-135.

[2]Ibid. p. 135.

these ratings could have on teacher behavior.[1,2] Roy C. Bryan, studying the use of pupil ratings to improve teacher effectiveness, asked pupils to rate their teachers at the beginning of the school year.[3] These ratings were then tabulated and given to the respective teachers. A second rating was then performed at the end of the semester on these same teachers by the same group of students. Teachers given the rating feedback received more favorable ratings at the end of the semester than at the beginning of the semester, supporting the hypothesis that student ratings would affect subsequent teacher behavior. Similar results were achieved in a study by Hayes et. al.[4]

In order to facilitate the ability of teachers to react to student needs, Hedges and MacDougall urged that a monitoring device be implemented to tell the teacher what

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[1]R.D. Kellough, "Evaluation of Teachers by Students: Let Us Comprehend the Nature of This Demand," Science Education, October, 1971, pp. 439-440.

[2]Royal P. Murdock, "The Effect of Student Ratings of their Instructor on the Student Achievement and Rating," Final Report, Utah University, Salt Lake City, Office of Education, Washington, D.C., Bureau of Research, October, 1969.

[3]Roy C. Bryan, "Pupil Ratings of Secondary School Teachers," School Review, Vol. 46, May, 1938, pp. 357-367.

[4]Robert B. Hayes, Floyd N. Keim and Albert M. Neiman, "The Effects of Student Reactions to Teaching Methods," Office of Education, Washington, D.C., September, 1967.

the students perceived to be going on in the classroom so that the teacher might have immediate feedback.[1] Miller and Philbrick, in 1953, provided this communication between teacher and students by way of electronic circuitry.[2] Froelich, with a similar student responder, obtained instant feedback for multiple choice and true-false questions at a naval training station.[3] Delaney also used a similar feedback device in his classroom for sampling and testing.[4]

Perhaps the most elaborate of these devices is that described by Muller.[5] This system (installed by the General Electric Company) at the University of Syracuse consists of student response units which are monitored on a large panel provided for the teacher at the front of the room. As the lesson proceeds, students respond with reactions such as "understand", "true", "false", etc. A computer tallies them and the totals are flashed on the teacher's monitor panel. The teacher not only receives this instant

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[1]W.D. Hedges and M.A. MacDougall, "Recording Student Perceptions of Teacher Behavior by Means of a Student Response Monitor," The Journal of Educational Research, Vol. 58, No. 4, 1964, pp. 163-166.

[2]D.C. Miller and W.W. Philbrick, "The Measurement of Group Learning Process by Use of the Interaction Telemeter," American Sociological Review, 1953, pp. 184-189.

[3]H.P. Froelich, "What About Classroom Communicators?" AV Communication Review, Vol. 11, No. 3, 1963.

[4]L.J. Delaney, Jr., "A Device for Quality Control in the Classroom," School Science and Mathematics, Vol. 64, 1964.

[5]R.L. Muller, "Student Responses in Lecture Instruction," Audiovisual Instruction, February, 1966.

feedback, but is presented with a print-out of the reactions of the entire class that can also be synchronized with a video tape of the same lesson.

The type of program just outlined is extremely expensive and findings indicate it has very limited effects because of the tendency of the teacher to turn off or to ignore the monitor. Those teachers who did use the device fairly, however, did evidence some change in behavior, at least as far as their general attitude toward their students was concerned.

What effects, if any, has feedback had on teacher behavior? In nearly all of the studies on pupil ratings, the results can be best illustrated by the study performed by Gage et. al.[1] Gage, Runkel and Chatterjee have stated that the resultant change in behavior of the teacher who has been given student rating results can be described by utilizing equilibrium theory. In their experiment, pupils were asked to rate their teachers at different times during the semester. The experimenters reasoned that since the students' reactions become more positive at each subsequent rating, the teacher's behavior must be changing toward what the pupils felt was more effective teaching strategy. Albert, after developing his own rating scale, also supported the previous findings that student ratings do have an effect on

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[1]N.L. Gage, Philip J. Runkel, and B.B. Chatterjee, "Equilibrium Theory and Behavior Change: An Experiment in Feedback from Pupils to Teachers," Bureau of Educational Research, University of Illinois, Urbana, Illinois, August, 1960.

teacher performance.[1]

On the question of accuracy of pupil ratings, a study by Earl C. Bowman compared ratings given to student teachers by pupils and those given by critic teachers to the same student teachers.[2] His findings indicated very little agreement between pupil and critic teacher as to the presence or absence of desirable teacher traits as described by the Purdue Rating Scale of Teacher Efficiency. At first glance, one would then question the accuracy of pupil ratings. However, other research on similar topics makes one more suspect of the critic teacher rather than the pupils. For example, in a review of literature on pupil ratings performed by Remmers, it was pointed out that student evaluation is proven "reliable", "convenient", "useful", and "valid", and that ratings of teachers by groups of 25 or more students are as reliable as any other means of rating.[3]

Further, Kochendorfer utilized the ratings of students to determine if teachers were meeting the curriculum objec-

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[1]H.P. Albert, "An Analysis of Teacher Ratings by Pupils in San Antonio, Texas," Educational Administration and Supervision, Vol. 227, April, 1941, pp. 267-274.

[2]Earl C. Bowman, "Pupil Ratings of Student Teachers," Educational Administration and Supervision, Vol. 20, February, 1934, pp. 141-146.

[3]N.L. Gage, Handbook of Research on Teaching, Chicago: Rand McNally and Co., 1963, p. 367.

tives of the Biological Science Curriculum Study Committee.[1] In testing his newly developed student checklist, he found it to have a reliability coefficient of .96 and a validity coefficient of .84 when testing student ratings against "expert opinion". Smith, reporting on the results of the Student Evaluation of Teachers Committee, found the pupils to be ". . . competent judges of teaching skill."[2]

It has been shown that pupil awareness on the part of the teacher leads to more effective teaching; studies using pupil ratings have shown that they have some effect on teacher behavior; pupil ratings are as reliable as any other means of rating teacher behavior. Therefore it challenges us as educators to utilize this source of help, the student, to aid us in the training of teachers to be more aware and able to cope with the dynamics of the classroom.

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[1]Leonard H. Kochendorfer, "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology," University of Texas, Austin, 1969.

[2]Alden W. Smith, "Students Evaluate Teaching," U.S. Department Health, Education and Welfare, Office of Education, 1969.

III. THE DATA AND FINDINGS

The eighteen teachers participating in the study had a mean age of 26, with a range of 21 through 50. The number of years experience in teaching ranged from one year through twenty years with a mean of six years. There were fifteen males and three females graduated from fourteen different colleges and universities, only one of which was from outside the state of Pennsylvania. The participating classes, made up of 444 students, were predominately fifteen years old, tenth-grade Biology I students. The students came from backgrounds ranging from the lower to the upper-socio-economic group with the majority ranging in the middle-socio-economic areas. The student I.Q. as measured by the Otis Intelligence Test ranged from a low of 71 to a high of 136 with a mean of 108 and a standard deviation of 13.

Finding 01

The per cent of teacher talk (the time in which the teacher was coded or speaking during a class period) for each of the nine transcribed lessons was analyzed using a two-way analysis of variance, consisting of three rows (each of the three months) and eighteen columns (each of the eighteen teachers).[1] The summary of the data, shown in Table 2, leads

[1]Ann Hughes and Dennis Grawoig, Statistics: A Foundation for Analysis, Reading, Massachusetts: Addison-Wesley Publishing Company, 1971.

TABLE 2

THE MEAN PERCENTAGES OF TEACHER TALK FOR EACH TEACHER OVER THE COMBINED THREE MONTH PERIOD OF THE STUDY TESTED FOR STATISTICAL SIGNIFICANCE USING A TWO-WAY ANALYSIS OF VARIANCE

Month	Mean	Sum of Squares	Mean Squares
1	85.20	SSM = 574.60	MSM = 287.30
2	83.01		
3	80.59		
Teacher			
1	84.33	SST - 5998.27	MST = 352.83
2	86.11		
3	84.66		
4	82.44		
5	77.88	F-Ratios:	
6	84.22		
7	84.66	3.44 - For Months = (.05)*	
8	88.22		
9	81.44	4.23 - For Teachers = (.01)+	
10	79.88		
11	77.22		
12	87.55		
13	82.22		
14	95.55		
15	79.88		
16	87.77		
17	64.66		
18	84.11		
Grand Mean	82.93		

*To be read as significant at the 5% level for 2 Degrees of Freedom

+To be read as significant at the 5% level for 17 Degrees of Freedom

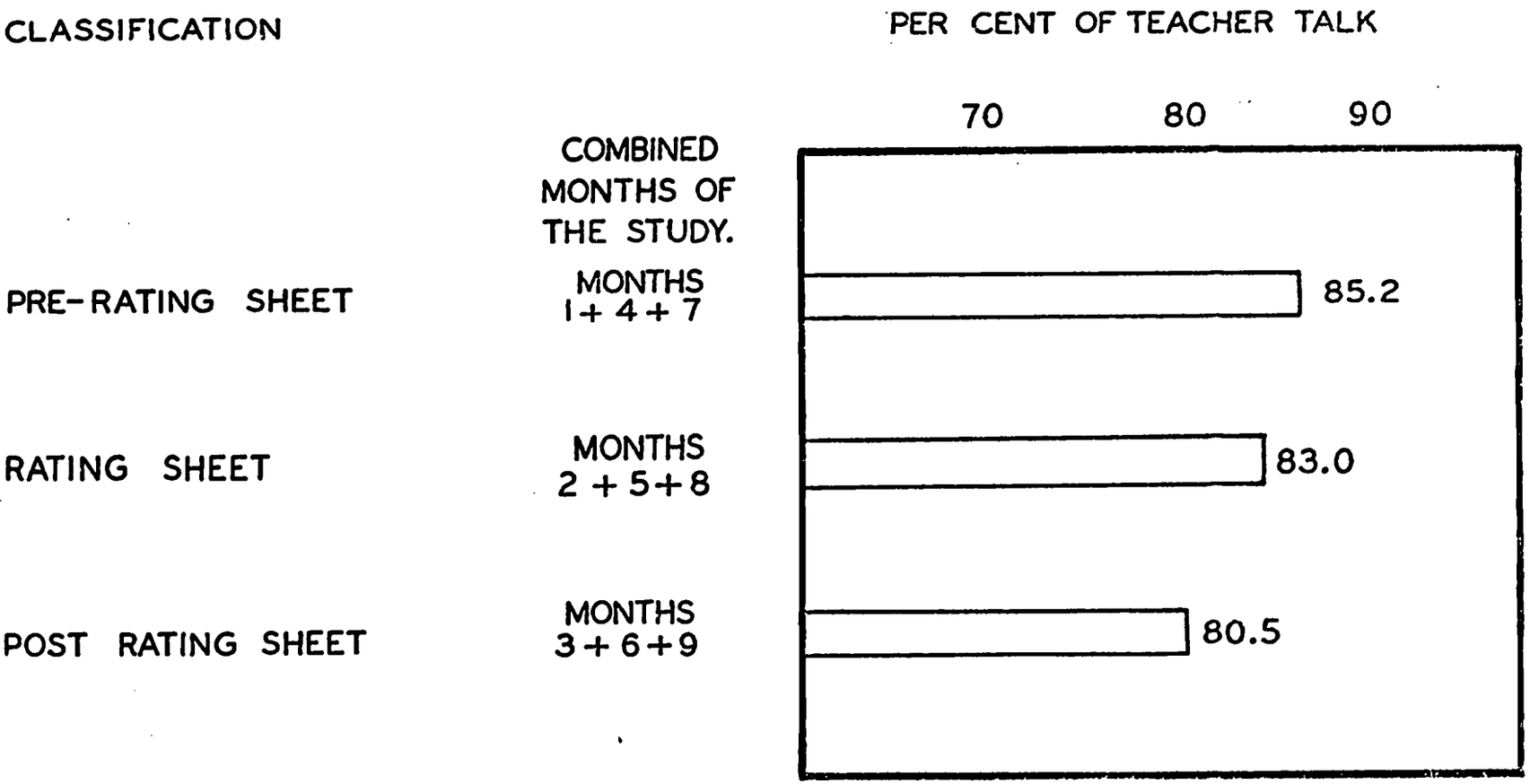

FIGURE 1

THE MEAN PER CENT OF TEACHER TALK FOR THE COMBINED THREE MONTHS OF THE EXPERIMENT FOR ALL TEACHERS.

to the rejection of the null hypothesis HO_1, as stated on page six, at the five per cent level of significance. Figure I further illustrates the trend of difference being a decline in the overall per cent of teacher talk for the combined three month periods of the study.

Finding 02

Table 3 presents the results of statistical analysis of the data taken from the six set matrix made from the nine audio tapes from each individual teacher.[1] Chi square tests were done for each of the eighteen teachers for all months.[2] A three by three contingency table was set up with the observed taken from the six set matrix and the expected derived from the nine cell contingency table with modes of teaching representing rows and months representing columns (see Appendix F for table of observed data). Sixteen of the eighteen tests were found significant at the five per cent level. The greatest non-significant tests were found in comparisons of months one to three and months two to three. From these results it was possible to reject hypothesis HO_2 as found on page six.

Finding 03

Declining amounts of teacher-lecture classes are

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[1]Gene W. Moser and Roberta Feldgoise, "Project in the Use of Interaction Analysis to Increase the Use of the Inquiry Method in the Teaching of Science," Science Project Center Report, April, 1968.

[2]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences, New York: McGraw Hill Book Company, 1956, pp. 63-67.

TABLE 3

CHI SQUARE VALUE FOR THE DIFFERENCE IN PER CENT OF LECTURE, DISCUSSION AND TRANSITION FOR INDIVIDUAL TEACHERS COMPARED IN MONTHS ONE THROUGH THREE

Teacher	All Months	Month 1 to 2	Months 1 to 3	Months 2 to 3
A	18.4[A]	47.56[A]	40.21[A]	19.9[A]
B	78.38[A]	38.48[A]	42.69[A]	10.65[B]
C	4.33	10.27[B]	69.31[A]	16.81[B]
D	55.33[A]	36.36[A]	19.13[A]	17.28[A]
E	23.08[A]	12.57[B]	33.44[A]	6.04
F	25.87[A]	39.92[A]	7.73	33.12[A]
G	71.90[A]	5.97	12.43[B]	9.48[B]
H	24.09[A]	20.00[A]	2.00	18.31[A]
I	99.52[A]	30.61[A]	29.20[A]	20.82[A]
J	23.19[A]	4.15	5.48	5.82
K	13.36[A]	23.17[A]	20.88[A]	9.68[B]
L	12.56[A]	36.98[A]	5.42[B]	4.82
M	19.12[A]	27.71[A]	7.72	5.07
N	41.93[A]	19.44[A]	23.98[A]	26.88[A]
O	12.02[B]	2.44	6.81	13.04[B]
P	46.60[A]	10.06[B]	12.73[B]	21.54[A]
Q	21.16[A]	19.90[A]	10.44[A]	10.84[B]
R	8.91	14.49[A]	17.13[A]	25.38[A]

A - To be read as significant at the 5% level for 4 Degrees of Freedom.
B - To be read as significant at the 1% level for 4 Degrees of Freedom.

again shown by the two way analysis of variance.[1] Data taken from the six set analysis for all teachers for all months of the study for the mean per cent of lecture is illustrated in Table 4. The data results in the rejection of HO_3 which states there would be no difference in the amount of lecture at the one per cent level of significance. Figure II illustrates that once again the direction of change is toward a decrease in the percentage of lecture in each successive month.

Finding 04

Two lessons per teacher were matched with the middle thirty minutes of the timed student response sheets completed during the same thirty minute analysis of the per cent of lecture during that lesson. Each category of student response was tested for correlation with the per cent of lecture.[2] No significant correlations were found for the student response categories "Too Fast", "Too Slow" and "Don't Understand", "Bored" and "Interested" (see Appendix L). However, as shown in Table 5, a positive correlation was found for the student response indicating their understanding the lecture. A negative correlation occurred with the student response of "Good". The data was then subjected to a regression analysis. The slopes and intercepts for student responses are shown in Figures III and IV.

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[1]Hughes, Op. Cit.

[2]George Gaylord Simpson, Ann Roe and Richard C. Lewontin, Quantitative Zoology, New York: Harcourt Brace and Company, 1960, p. 440.

TABLE 4

THE MEAN PERCENTAGES OF LECTURE FOR EACH TEACHER OVER THE COMBINED THREE MONTH PERIOD OF THE STUDY TESTED FOR STATISTICAL SIGNIFICANCE USING A TWO-WAY ANALYSIS OF VARIANCE

Month	Mean	Sum of Squares	Mean Squares
1	59.91	SSM = 5930.45	MSM = 2965.22
2	51.64		
3	45.13		
Teacher			
1	54.07	SST = 22627.38	MST = 1331.02
2	57.70		
3	51.21		
4	52.84		
5	83.44	F-Ratios:	
6	43.73		
7	63.45	9.70 - For Months = (.01)*	
8	57.57		
9	66.88	4.35 - For Teachers = (.01)+	
10	40.58		
11	56.32		
12	40.05		
13	56.10		
14	48.94		
15	31.11		
16	47.92		
17	35.72		
18	52.45		
Grand Mean	52.23		

* To be read as significant at the 1% level for 2 Degrees of Freedom.

+To be read as significant at the 1% level for 17 Degrees of Freedom.

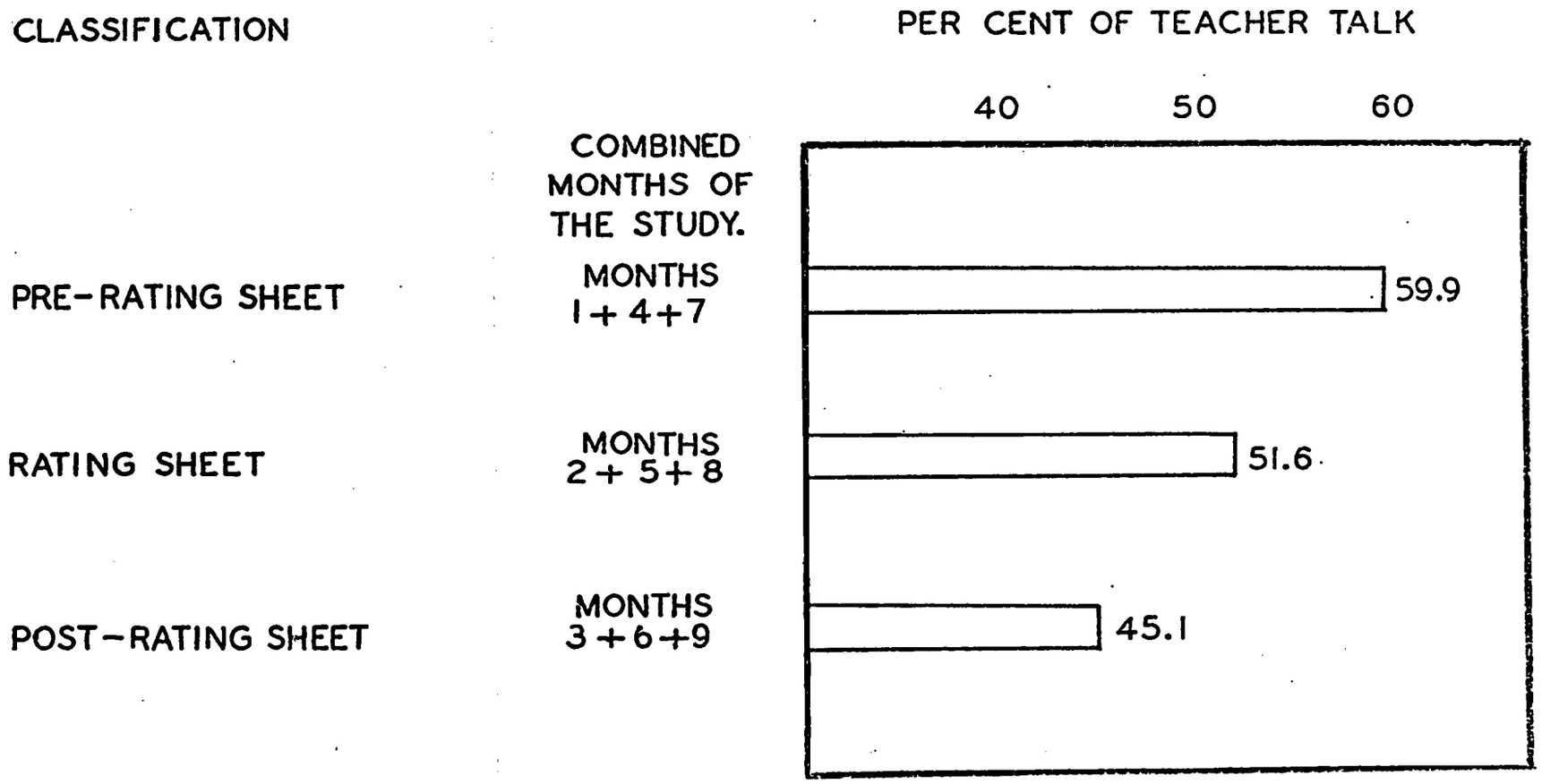

FIGURE II

THE MEAN PER CENT OF LECTURE FOR THE COMBINED THREE MONTHS OF THE EXPERIMENT FOR ALL TEACHERS.

TABLE 5

CORRELATION OF THE PER CENT OF LECTURE IN A LESSON WITH THE PER CENT OF STUDENT RESPONSES INDICATING "GOOD" OR "UNDERSTAND" FOR THAT SAME LESSON

Per Cent Lecture Vs. Student Response "Understand"	
N	17
$\bar{X}$ (Per cent of lecture)	.471
$\bar{Y}$ (Per cent of student response "understand")	.282
rxy	+.7502*
byx	+.295
ay	+.1429

Per Cent Lecture Vs. Student Response "Good"	
N	17
$\bar{X}$ (Per cent of lecture)	.471
$\bar{Y}$ (Per cent of student response "good")	.1905
rxy	-.5737+
byx	-.2729
ay	+.3192

* - To be read as significant at the .05 level.

+ - To be read as significant at the .01 level.

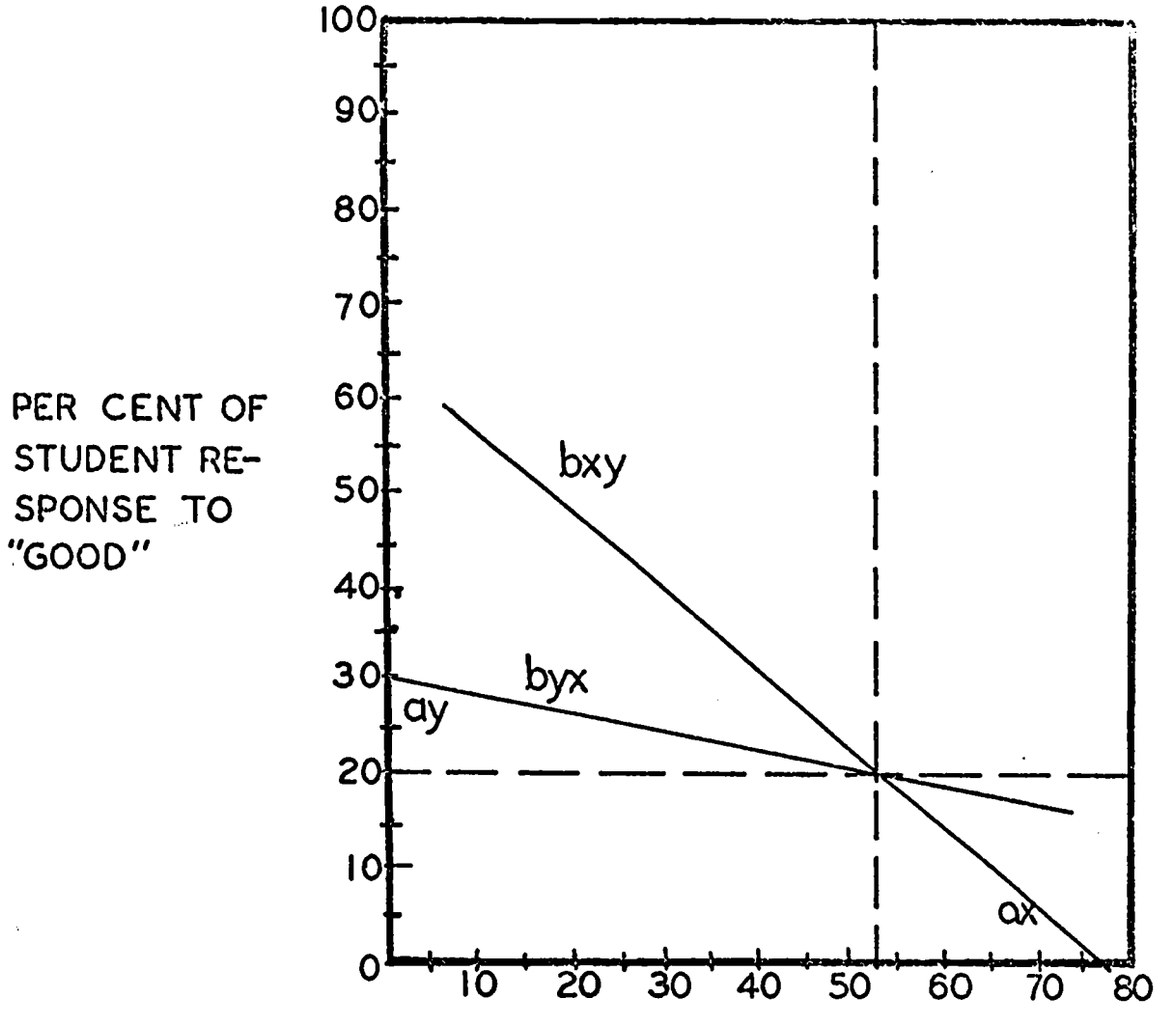

FIGURE III

PER CENT OF LECTURE

SLOPES AND INTERCEPTS OF THE CORRELLATION OF THE PER CENT OF STUDENT RESPONSE OF "GOOD" WITH THE PER CENT OF TEACHER LECTURE DURING THE SAME TIME PERIOD.

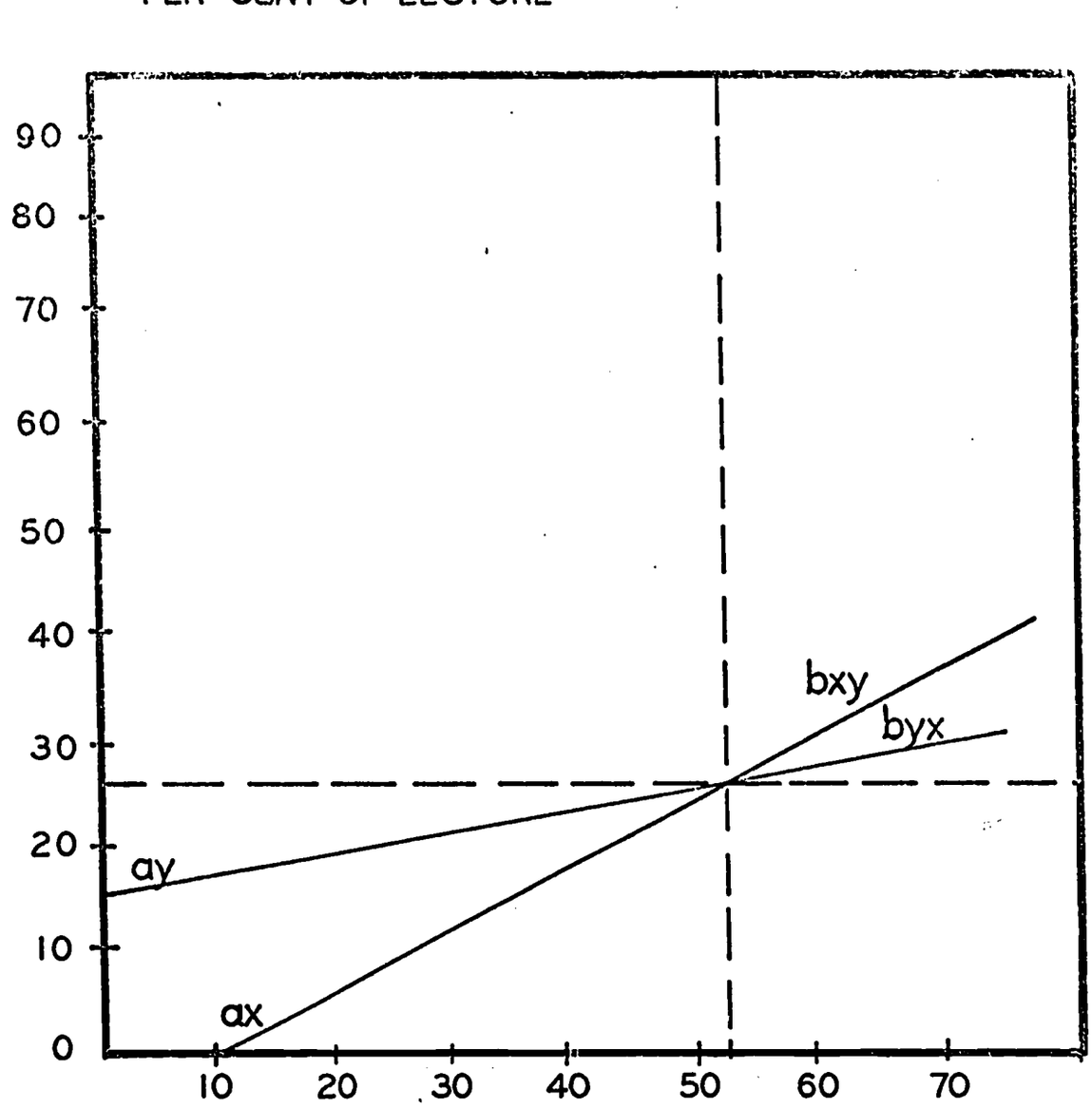

FIGURE IV

SLOPES AND INTERCEPTS OF THE CORRELLATION OF THE PER CENT OF THE STUDENT RESPONSE OF "UNDERSTAND" WITH THEAMOUNT OF TEACHER LECTURE DURING THE SAME TIME PERIOD.

Finding 05

The changes in lecture, transition and discussion modes of teaching were shown to differ significantly over the three months of the study as illustrated in Table 3. However, the inquiry aspect of the six set system was not tested for statistical significance.[1] As can be seen in Table 6, the percentages of inquiry per lesson were too low to be tested.

TABLE 6

THE PER CENT OF INQUIRY PER LESSON PER MONTH FOR EACH TEACHER

Teacher	Month 1 Lesson			Month 2 Lesson			Month 3 Lesson		
	1	2	3	1	2	3	1	2	3
1	.4	0	1.1	0	0	0	0	0	2.2
2	.1	0	1.7	.3	0	1.3	0	1.4	23.8
3	0	0	0	0	36.9	0	11.2	0	11.7
4	0	0	0	0	0	0	0	8.7	2.5
5	1.2	1.2	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1.1	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	18.5	0	0	0
10	0	0	2.8	14.5	0	1.2	0	18.0	0
11	0	0	0	1.8	0	0	5.4	7.3	4.3
12	0	1.1	12.7	21.3	8.7	6.2	1.1	10.2	6.0
13	0	0	0	1.1	0	0	0	12.0	0
14	0	0	0	2.4	1.2	1.2	2.1	0	40.0
15	0	9.6	15.0	40.0	7.0	2.0	5.9	2.1	17.3
16	0	0	0	0	0	0	0	0	2.0
17	0	0	0	0	0	0	0	2.0	0
18	0	0	0	3.9	0	0	0	0	1.1

[1]Moser, Op. Cit.

Finding 06

Two lessons per teacher were matched with the middle thirty minutes of the timed student response sheets completed during the same thirty minute analysis of the per cent of lecture during that lesson. Each category of student response was correlated with the per cent of discussion. No significant correlations were found for the student response categories "Too Fast", "Too Slow" and "Don't Understand". However, as shown in Table 7, in contrast to lecture, discussion is found to be negatively correlated with the student response of "Understand" and positively correlated with "Good". The other categories ("Too Fast", "Too Slow" etc.) were found to be consistent with the previous non-significant correlations. The data were then subjected to a regression analysis.[1] The slopes and intercepts for student responses are shown in Figures V and VI.

Finding 07

A correlation was then computed for the per cent of transition with the per cent of student response for the same time period. As can be seen in Table 8, there is a positive correlation of transition with "Good" significant at the one per cent level and a negative correlation between transition and "Understand", also significant at the one per cent level. The slopes and intercepts for student responses are shown in Figures VII and VIII.

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[1]Hughes, Op. Cit.

TABLE 7

CORRELATION OF THE PER CENT OF DISCUSSION IN A LESSON WITH THE PER CENT OF STUDENT RESPONSES INDICATING "GOOD" OR "UNDERSTAND" FOR THAT SAME LESSON

Per Cent Discussion Vs. Student Response "Understand"	
N	17
$\bar{X}$ (Per cent of discussion)	.1539
$\bar{Y}$ (Per cent of student response "understand")	.282
rxy	-.5830*
byx	-.4978
ay	+.35866

Per Cent Discussion Vs. Student Response "Good"	
N	17
$\bar{X}$ (Per cent of discussion)	.1539
$\bar{Y}$ (Per cent of student response "good"	.1905
rxy	$+.4476^{+}$
byx	+.4622
ay	.11939

* - To be read as significant at .01 level.

$^{+}$ - To be read as significant at .07 level.

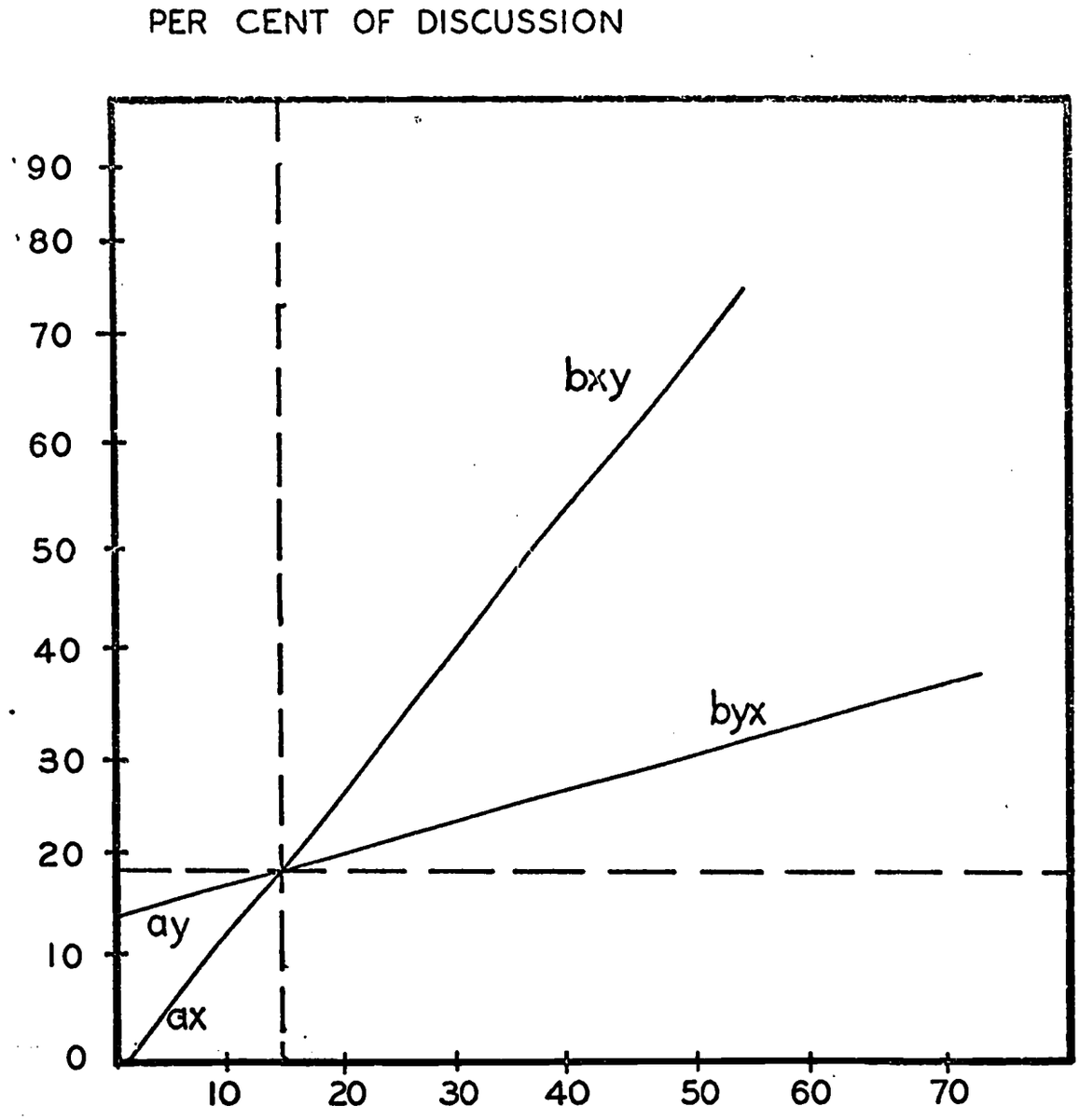

FIGURE V

SLOPES AND INTERCEPTS OF THE CORRELLATION OF THE PER CENT OF THE STUDENT RESPONSE OF "GOOD" WITH THE PER CENT OF CLASS DISCUSSION DURING THE SAME TIME PERIOD.

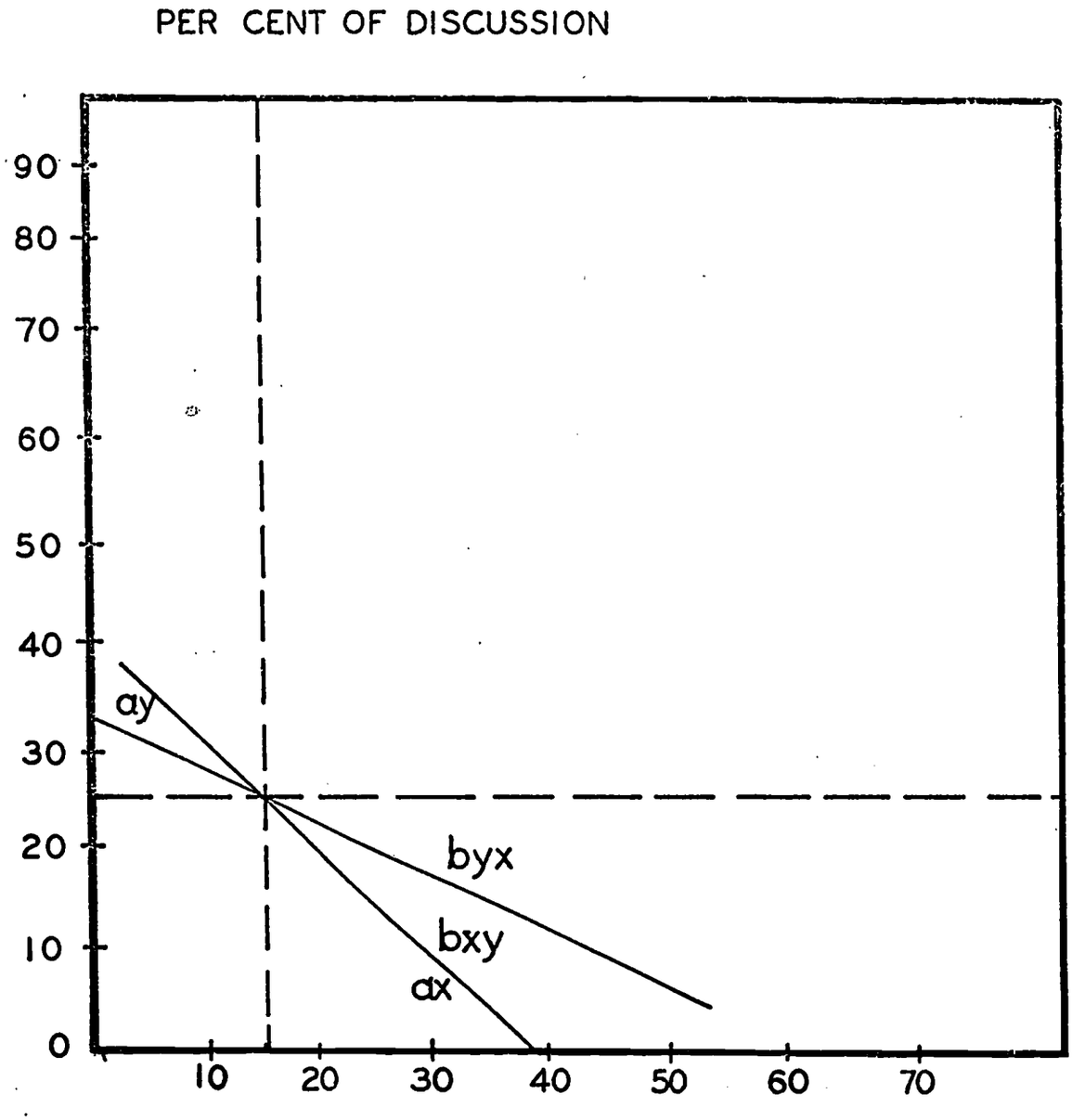

FIGURE VI

SLOPES AND INTERCEPTS FOR THE CORRELLATION OF PER CENT OF THE PER CENT OF STUDENT RESPONSE OF "UNDERSTAND" WITH THE PER CENT OF CLASS DISCUSSION DURING THE SAME TIME PERIOD.

TABLE 8

CORRELATION OF THE PER CENT OF TRANSITION IN A LESSON WITH THE PER CENT OF STUDENT RESPONSES INDICATING "GOOD" OR "UNDERSTAND" FOR THAT SAME LESSON

Per Cent Transition Vs. Student Response "Understand"	
N	17
$\bar{X}$ (Per cent of transition)	.378
$\bar{Y}$ (Per cent of student response "understand")	.282
rxy	-.661*
byx	-.346
ay	+4.133

Per Cent Transition Vs. Student Response "Good"	
N	17
$\bar{X}$ (Per cent of transition)	.378
$\bar{Y}$ (Per cent of student response "good")	.190
rxy	+.637*
byx	+.404
ay	+.037

* - To be read as significant at the .01 level.

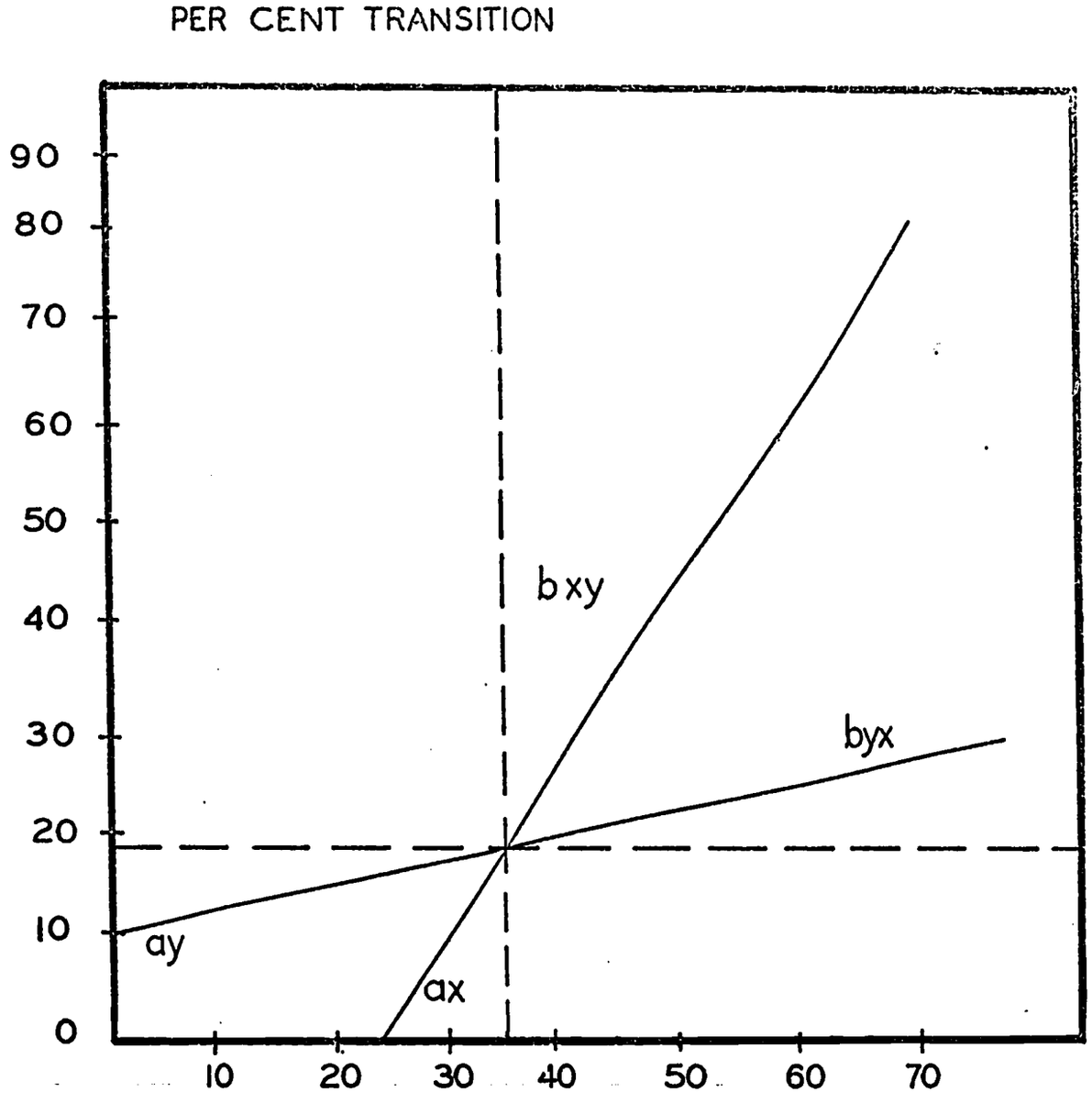

FIGURE XII

SLOPES AND INTERCEPTS FOR THE CORRELLATION OF THE PER CENT OF STUDENT RESPONSE OF "GOOD" WITH THE PER CENT OF TRANSITION OCCURRING DURING THE SAME TIME PERIOD.

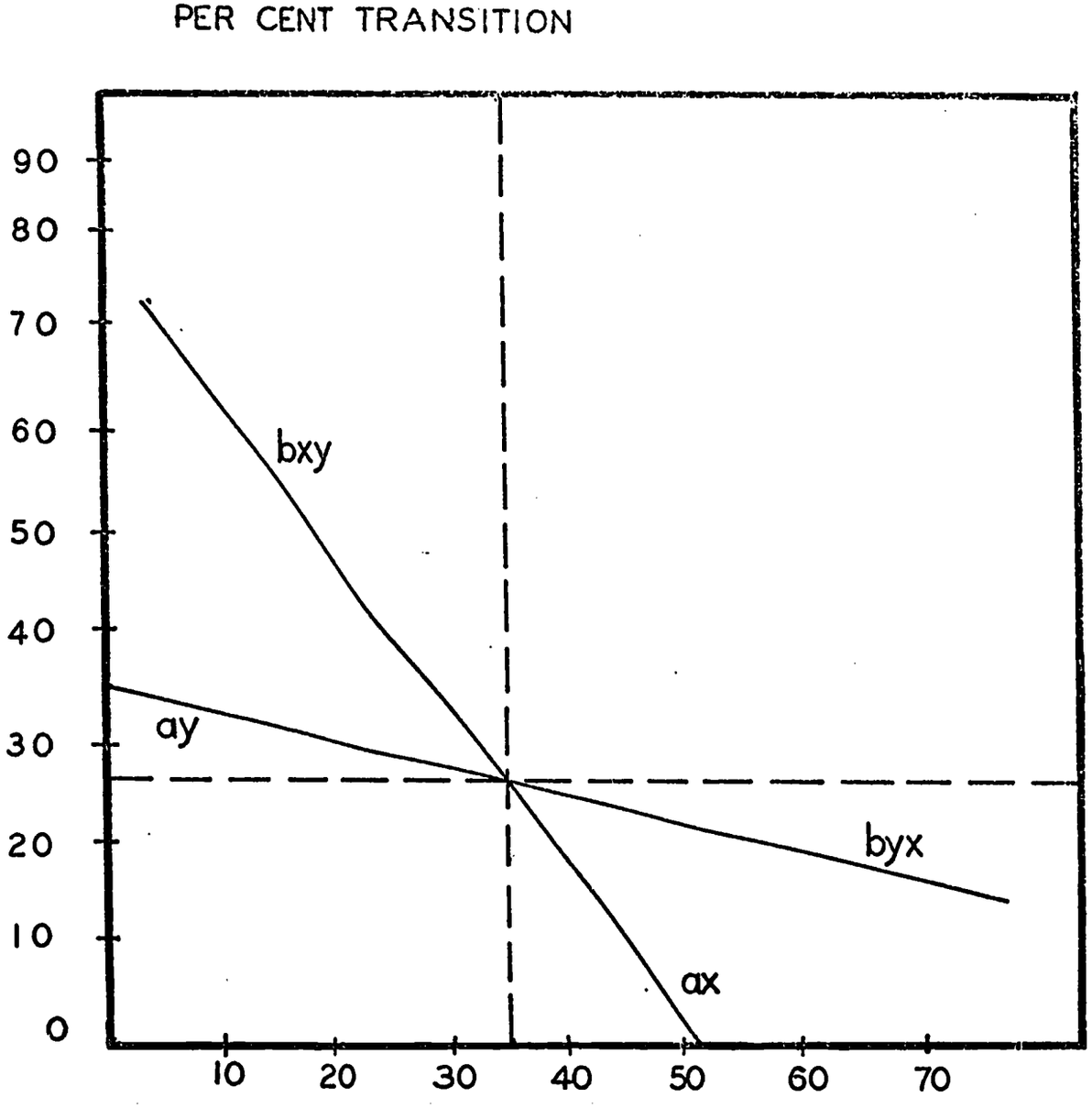

FIGURE VIII

SLOPES AND INTERCEPTS FOR THE CORRELLATION OF THE PER CENT OF STUDENT RESPONSE OF "UNDERSTAND" WITH THE PER CENT OF TRANSITION OCCURRING DURING THE SAME TIME PERIOD.

Finding 08

The numbers of non-routine questions (those questions which are asked by a teacher which require thought about subject matter by the student) asked by teachers over a thirty minute middle section of each lesson were analyzed. The analysis was made for statistically significant differences over the three month time period of the study. The results of this two-way analysis of variance, shown in Table 9, lead to the rejection of null hypothesis HO_5 as stated on page seven. Hypothesis five states that there will be no significant difference in the amount of non-routine questions asked during a class over all three months of the study. It will also be noted in Table 9 that the mean number of questions actually decreases over the three month period. This finding may be used to demonstrate that since the bulk of the questions asked by all eighteen teachers were quiz type, short answer, cognitive memory questions, a definite student response on the pupil rating sheets must have indicated a dislike for this technique. Samples of anecdotal comments are as follows: "Why do you grill us?", "Why do you try to embarrass us?" and "I don't like it when you ask me all those questions". The decrease in overall number of non-routine questions asked could then be indicative of teachers moving away from this objectionable, as far as the pupil is concerned, technique.

TABLE 9

THE MEAN PERCENTAGES OF INQUIRY FOR EACH TEACHER OVER THE COMBINED THREE MONTH PERIOD OF THE STUDY TESTED FOR STATISTICAL SIGNIFICANCE USING A TWO-WAY ANALYSIS OF VARIANCE

Month	Mean	Sum of Squares	Mean Squares
1	16.18	SSM = 754.97	MSM = 377.48
2	15.00		
3	11.12		
Teacher			
1	13.55	SST = 7999.43	MST = 470.55
2	24.22		
3	15.44		
4	11.00	F-Ratios:	
5	3.77		
6	30.00	7.32 - For months = (.01)*	
7	6.66		
8	15.55	9.12 - For Teachers = (.01)+	
9	22.44		
10	11.00		
11	9.77		
12	18.77		
13	9.11		
14	21.00		
15	11.44		
16	12.33		
17	1.77		
18	16.00		
Grand Mean	14.10		

* To be read as significant at the 1% level for 2 degrees of freedom.

+ To be read as significant at the 1% level for 17 degrees of freedom.

Finding 09

Table 10 illustrates the finding that there are very few divergent-type questions (divergent questions are those questions that require inductive reasoning on the part of the student and the ability to go beyond given data to draw conclusions) asked during the three month period of the study. Therefore it was felt that any statistical manipulation of the data would prove unreliable and misleading.

Finding 10

Table 11 shows that there is no statistically significant difference in the mean number of thought-type questions (thought questions are those questions which require inductive reasoning, deductive reasoning, or an evaluation of given data) over the three three month periods of the study, thus leading to acceptance of null hypothesis HO_7 found on page seven.

However, it will be noticed in Table 11 that the mean percentages for individual teachers in the number of thought-type questions asked was significant at the .05 level, showing that while teachers vary significantly in their general questioning techniques, they are not easily motivated to change these techniques.

Finding 11

Next to be analyzed was the number of student questions asked during each class during the three months of the study. As is shown in Table 12, there is a significant difference in pupil questions asked for each individual

TABLE 10

THE NUMBER OF DIVERGENT QUESTIONS ASKED PER LESSON PER MONTH FOR EACH TEACHER PARTICIPATING IN THE STUDY

Teacher	Month 1 Lesson			Month 2 Lesson			Month 3 Lesson		
	1	2	3	1	2	3	1	2	3
1	0	0	0	0	2	0	0	0	0
2	1	1	0	1	1	0	1	1	2
3	1	1	0	2	2	2	2	4	1
4	1	1	0	1	0	1	0	1	0
5	0	0	1	1	0	0	0	0	0
6	0	0	0	0	2	0	9	0	6
7	0	2	0	0	0	0	0	0	0
8	0	0	0	0	0	3	3	0	3
9	0	0	0	0	0	0	3	0	0
10	0	1	1	0	0	0	0	2	0
11	0	0	0	2	1	4	2	0	0
12	0	2	0	0	0	0	0	2	1
13	0	0	0	0	3	2	0	0	0
14	0	0	1	0	0	0	2	1	0
15	0	0	0	0	0	0	0	0	0
16	0	2	0	3	3	1	8	1	2
17	0	0	2	0	0	0	0	0	0
18	0	0	1	0	0	0	1	0	0

TABLE 11

THE MEAN PERCENTAGES OF THOUGHT-TYPE QUESTIONS ASKED BY EACH TEACHER OVER THE COMBINED THREE MONTH PERIOD OF THE STUDY TESTED FOR STATISTICAL SIGNIFICANCE USING A TWO-WAY ANALYSIS OF VARIANCE

Month	Mean	Sum of Squares	Mean Squares
1	4.40	SSM = 100.03	MSM = 50.01
2	6.22		
3	4.75		
Teacher			
1	6.00	SST = 996.05	MST = 58.59
2	10.66		
3	6.66		
4	2.55		
5	1.11		
6	8.66		
7	3.55		
8	6.33		
9	5.44		
10	4.88		
11	6.66		
12	5.11		
13	2.77		
14	4.33		
15	3.66		
16	8.55		
17	1.44		
18	3.88		
Grand Mean	5.12		

F-Ratios:

2.75 - For Months = not significant

3.22 - For Teachers = (.05)*

* To be read as significant at the 5% level for 17 degrees of freedom.

teacher. However, in comparing the three months for the teachers as a whole, Table 12 shows that there is no significant difference in the mean number of questions asked by students, thus leading to the acceptance of the null hypothesis HO_8 as shown on page seven.

Finding 12

Percentage of teacher time spent in inquiry-oriented activity (activities such as individual work on the part of the students, laboratory investigation in small groups or individuall, student-led discussion sessions:(see Appendix J) is illustrated in Figure IX. These could then be contrasted with the response made by students who completed the Science Activities Checklist as devised by Kochendorfer.[1] These results are shown in Figure X. It will be noted that those teachers that indicated high scores on the teachers' log also received high pupil assessments on the activities checklist. Although, as indicated on Table 13, that a number of teachers' logs show a significant difference in percentage of inquiry-oriented activities over the three months they participated in the study, this researcher has serious doubts as to the conscientiousness of the teachers when it came to filling out the time questionnaire log.

Finding 13

As a check on the accuracy of student ratings, the

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[1]Leonard H. Kochendorfer, "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology," University of Texas, Austin, 1969.

TABLE 12

THE MEAN PERCENTAGES OF STUDENT QUESTIONS ASKED OVER THE COMBINED THREE MONTH PERIOD OF THE STUDY TESTED FOR STATISTICAL SIGNIFICANCE USING A TWO-WAY ANALYSIS OF VARIANCE

Month	Mean	Sum of Squares	Mean Squares
1	0.039	SSM = 0.001	MSM = 0.0006
2	0.041		
3	0.046		
Students of Teachers			
1	0.048	SST = 0.075	MST = 0.0044
2	0.040		
3	0.054		
4	0.017		
5	0.103		
6	0.062		
7	0.055		
8	0.030		
9	0.030		
10	0.015		
11	0.027		
12	0.022		
13	0.038		
14	0.053		
15	0.012		
16	0.058		
17	0.031		
18	0.059		
Grand Mean	0.042		

F-Ratios:

0.944 - For Months = not significant

6.352 - For Students of Teachers = (.05)*

* To be read as significant at the 5% level for 17 degrees of freedom.

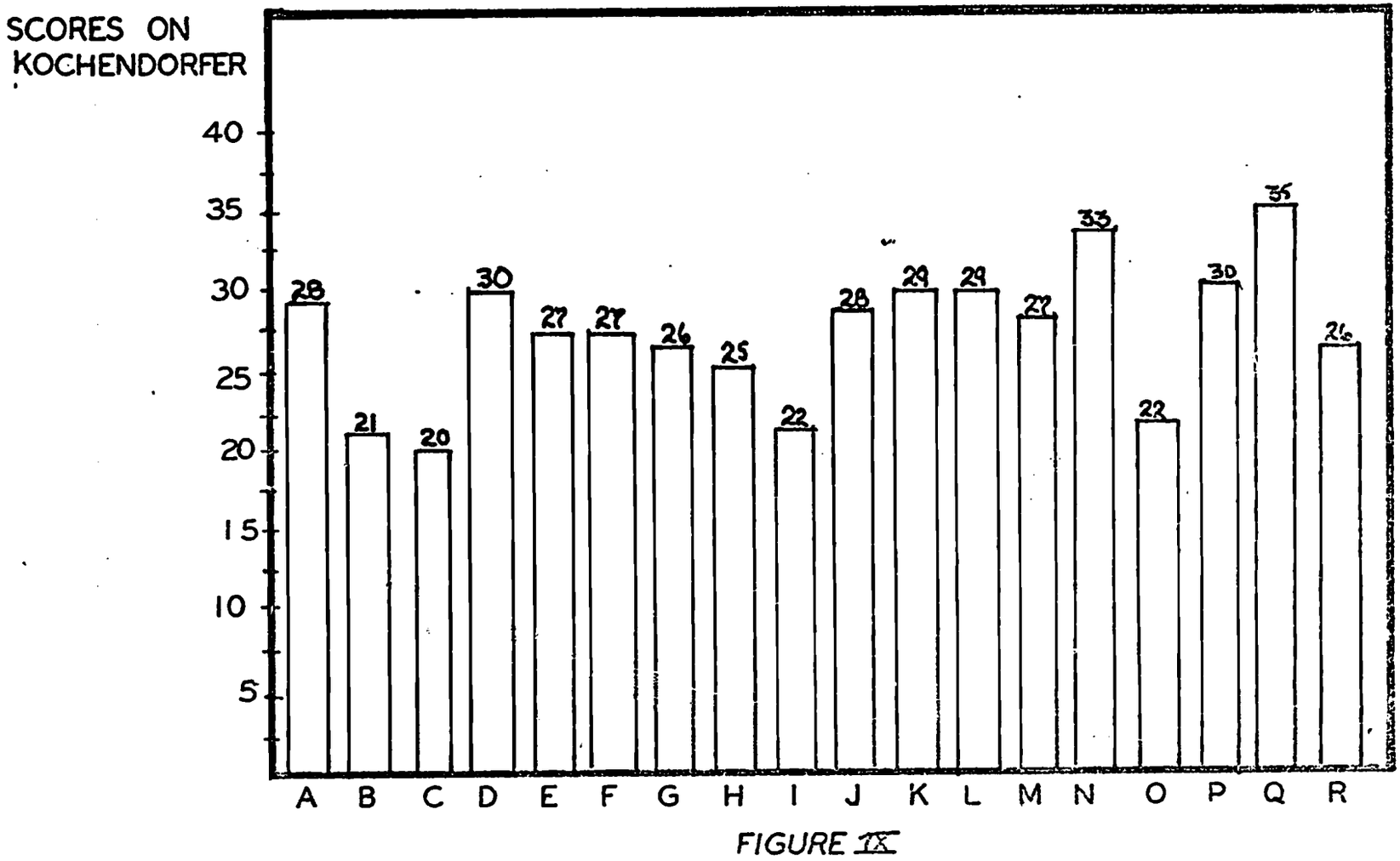

FIGURE IX

INDIVIDUAL SCORES GIVEN BY PUPILS TO TEACHERS ON THE KOCHENDORFER SCIENCE ACTIVITIES CHECKLIST.

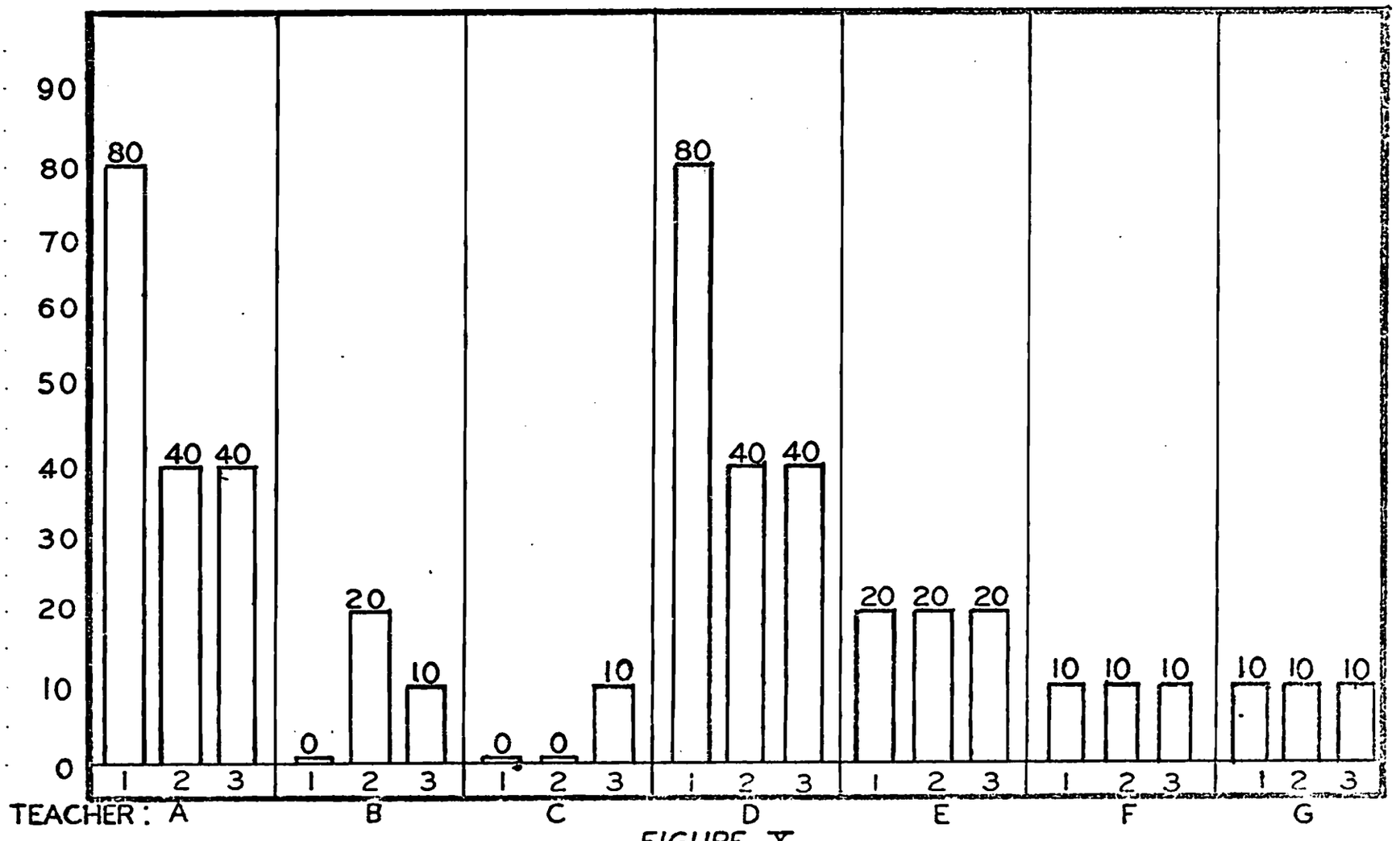

FIGURE X

COMPARING THE TEACHER LOGS FOR THE THREE THAT EACH TEACHER PARTICIPATED IN THE STUDY FOR THE PER CENT OF INQUIRING ORIENTED ACTIVITIES.

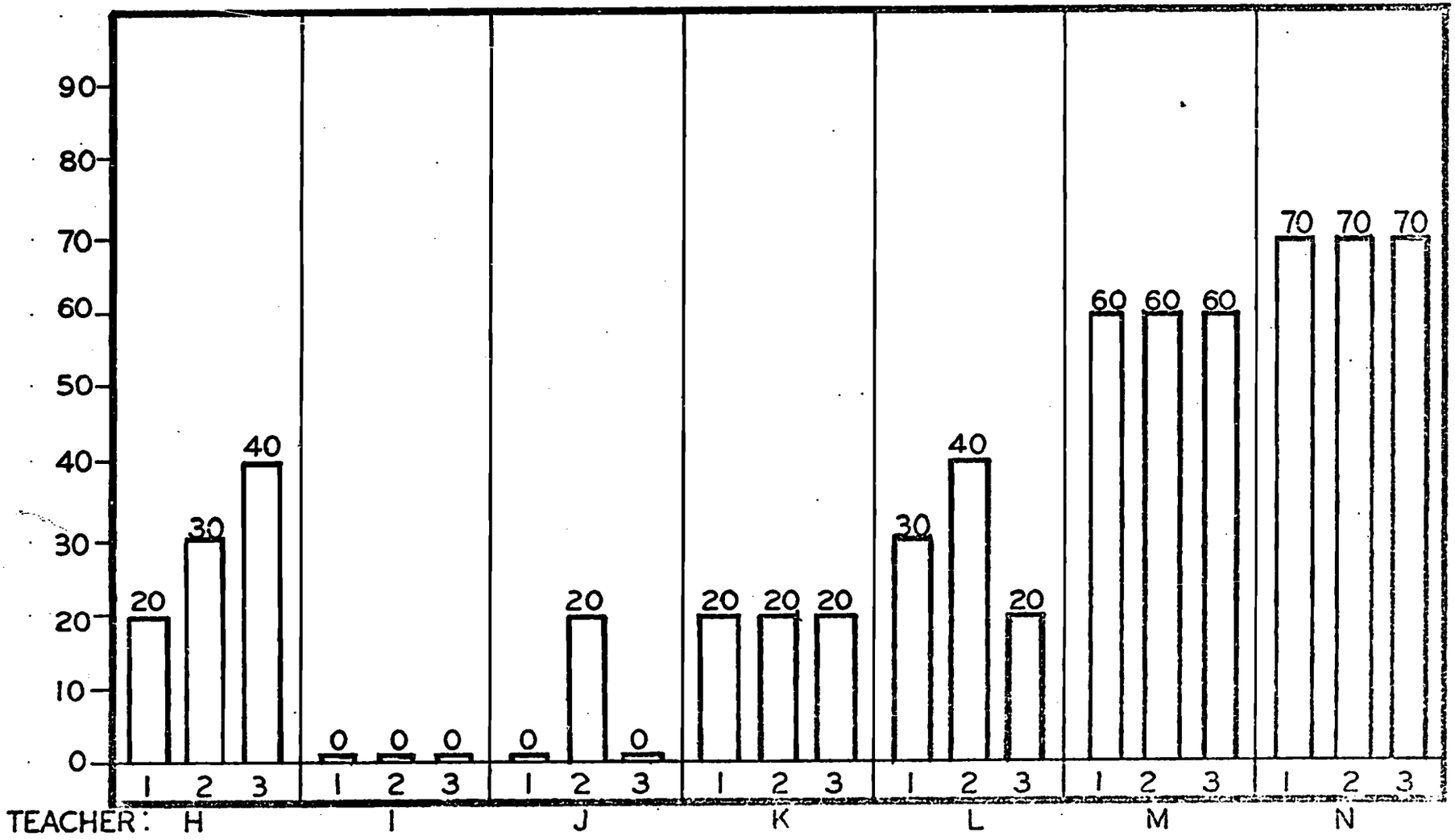

FIGURE X – CONT.

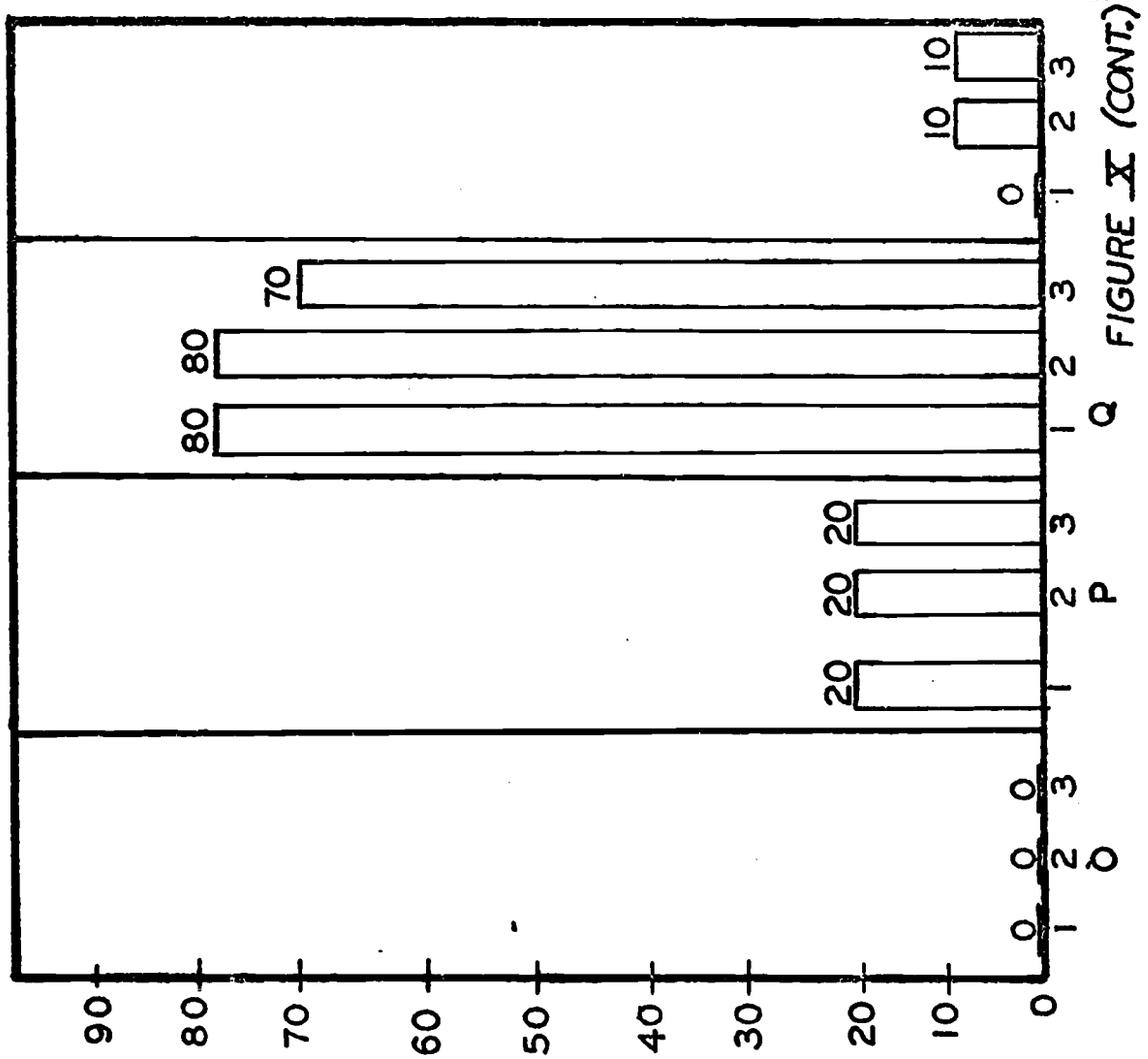

FIGURE X (CONT.)

TABLE 13

CHI SQUARE TESTS OF SIGNIFICANT DIFFERENCE IN THE PER CENT OF INQUIRY-ORIENTED CLASSROOM ACTIVITIES AS REPORTED BY THE TEACHERS ON THEIR TIME LOGS

Teacher	Month	Per Cent of Inquiry-Oriented Activity	Chi Square
A	1	20	5.12
	2	40	1.48
	3	40	1.48
			8.08*
B	1	.5	9.02
	2	19.5	9.02
	3	10	0.00
			18.04*
C	1	0	0
	2	0	0
	3	0	0
			0
D	1	80	13.37
	2	40	3.31
	3	40	3.31
			19.99*
E	1	20	0.00
	2	20	0.00
	3	20	0.00
			0.00
F	1	10	6.02
	2	20	.69
	3	20	.69
			7.40*
G	1	10	1.75
	2	9.5	1.27
	3	.5	5.63
			8.65*
H	1	20	3.33
	2	30	0.00
	3	40	3.33
			6.66*
I	1	0	0
	2	0	0
	3	0	0
			0

TABLE 13 CONTINUED

J	1	0	0
	2	20	00
	3	0	0
			0[a]
K	1	20	0
	2	20	0
	3	20	0
			0
L	1	30	3.33
	2	40	0
	3	20	3.33
			6.66*
M	1	60	0
	2	60	0
	3	60	0
			0
N	1	0	0
	2	0	0
	3	0	0
			0
O	1	20	0
	2	20	0
	3	20	0
			0
P	1	80	.1
	2	80	.1
	3	70	.56
			.76
Q	1	.5	5.63
	2	9.5	1.27
	3	10	1.75
			8.65*
R	1	70	0
	2	70	0
	3	70	0
			0

* = Significant at the 5% level
[a] = Insufficient data

results of the Kochendorfer, which was completed by students at the end of the second month, were correlated with the mean per cent of lecture, discussion, transition and inquiry (as defined by the six set system).[1,2] The results of these correlations are shown on Table 14.

Finding 14

Pupil ratings of teachers were placed into two categories, one defined as more positive in nature, ("Interested", "Understand" and "Good") and the other more negative in nature ("Bored", "Don't Understand", "Too Fast" and "Too Slow"). "Too Fast" and "Too Slow" are considered as one since they tend to focus on the same aspect of teacher behavior. The ratio of positive to negative was then computed for each lesson as it occurred during the month. These ratios were then graphed in a sequential manner and the results indicate, as illustrated by Figure XI, the overall movement of the teachers to garner a more positive rating from their students as the experimental month proceeded. Even though, as Figure XI points out, there was a drop in positive to negative ratios from the fourth time the rating response sheets were used to the fifth time, it still was several points above the original rating.

Finding 15

One of the response categories available to pupils was that category marked "Good". The per cent of the total

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[1]Kochendorfer, Op. Cit.

[2]Moser, Op. Cit.

TABLE 14

CORRELATION OF TEACHER SCORE ON THE KOCHENDORFER SCIENCE ACTIVITIES CHECKLIST WITH THE PER CENT OF THE MODE OF TEACHING AS INDICATED BY THE SIX SET

	N	ΣX	ΣY	$\bar{X}$	$\bar{Y}$	rxy	byx	ay
Lecture	18	479	937	26.6	52.0	-.372	-.012	+.857
Discussion	18	479	162	26.6	9.0	+.216	+.002	-.04
Transition	18	479	642	26.6	35.7	+.274	+.009	+.117
Inquiry	18	479	606	26.6	3.30	+.404	+.0048	-.09

X = Score on Kochendorfer

Y = Six Set Teaching Mode

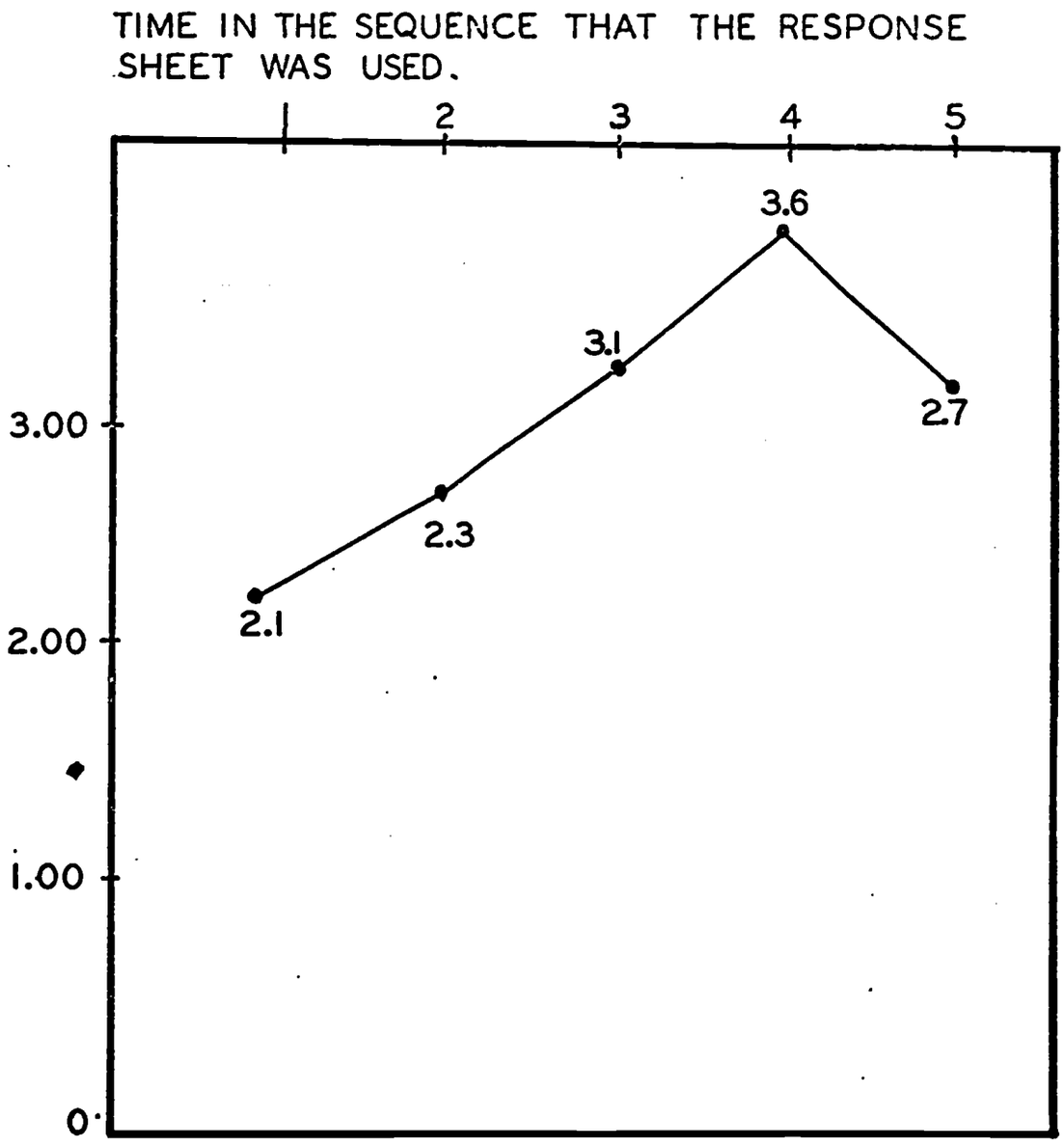

FIGURE XI

OVERALL RATIO OF POSITIVE STUDENT RESPONSES TO NEGATIVE STUDENT RESPONSES GIVEN TO ALL TEACHERS DURING THE SEQUENCE OF RATING SHEETS GIVEN TO TEACHERS DURING THE TREATMENT MONTH.

pupil responses to the category of "Good" also shows an overall trend of the teacher to move toward a more positive rating by his students. Figure XII illustrates that after a dip from the first time period to the second time period there is a slight overall rise from that point on.

Finding 16

One of the most confusing reactions of students was in the category of "Interested" and "Bored". Although once again showing a trend toward a more positive ratio, as illustrated in Figure XIII, the actual tallies of this rating showed that the numbers varied significantly from pupil to pupil for the same lesson from the same teacher. While the "Interested" and "Bored" showed the smallest ratio rise, during the same lessons the overall ratio of "Understand" to "Don't Understand" was rising dramatically.

Finding 17

The overall ratio of "Understand to "Don't Understand" is illustrated in Figure XIV. As the lesson proceeded, it would seem that the pupils' overall reaction during the experimental month indicated an increasing amount of understanding through the first four times the sheets were used, then dropping off on the fifth. However, the fifth rating sheet was still much higher than the third rating sheet. It will be noted at this point that only five of the rating sheets taken from a total of at least six for most teachers were used. The reason for using only the first five rating sheets was that some teachers, due to limiting factors,

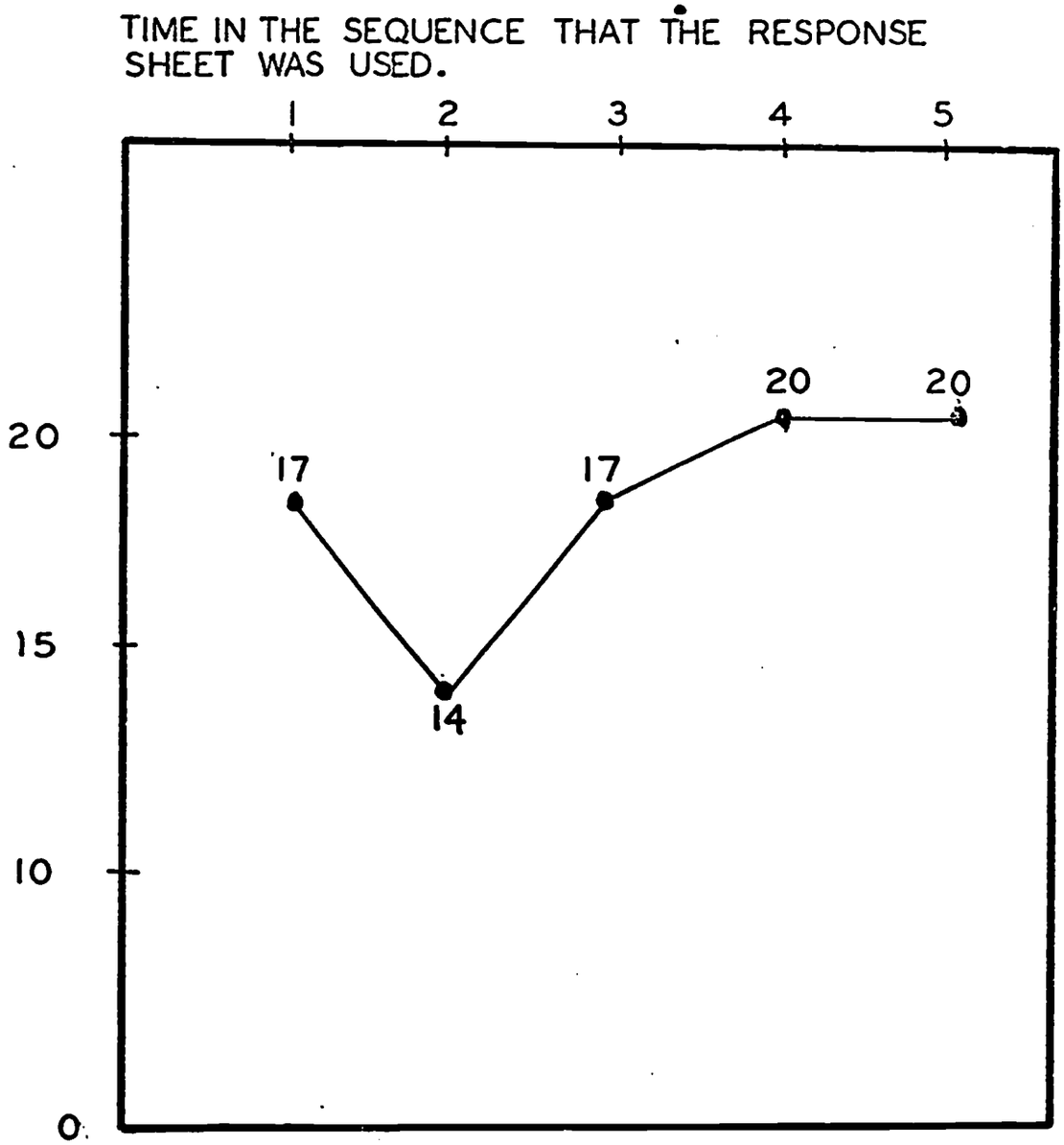

FIGURE XII

PER CENT OF TOTAL STUDENT RESPONSE TO "GOOD" DURING THE SEQUENCE OF RATING SHEETS GIVEN TO TEACHERS DURING THE TREATMENT MONTH.

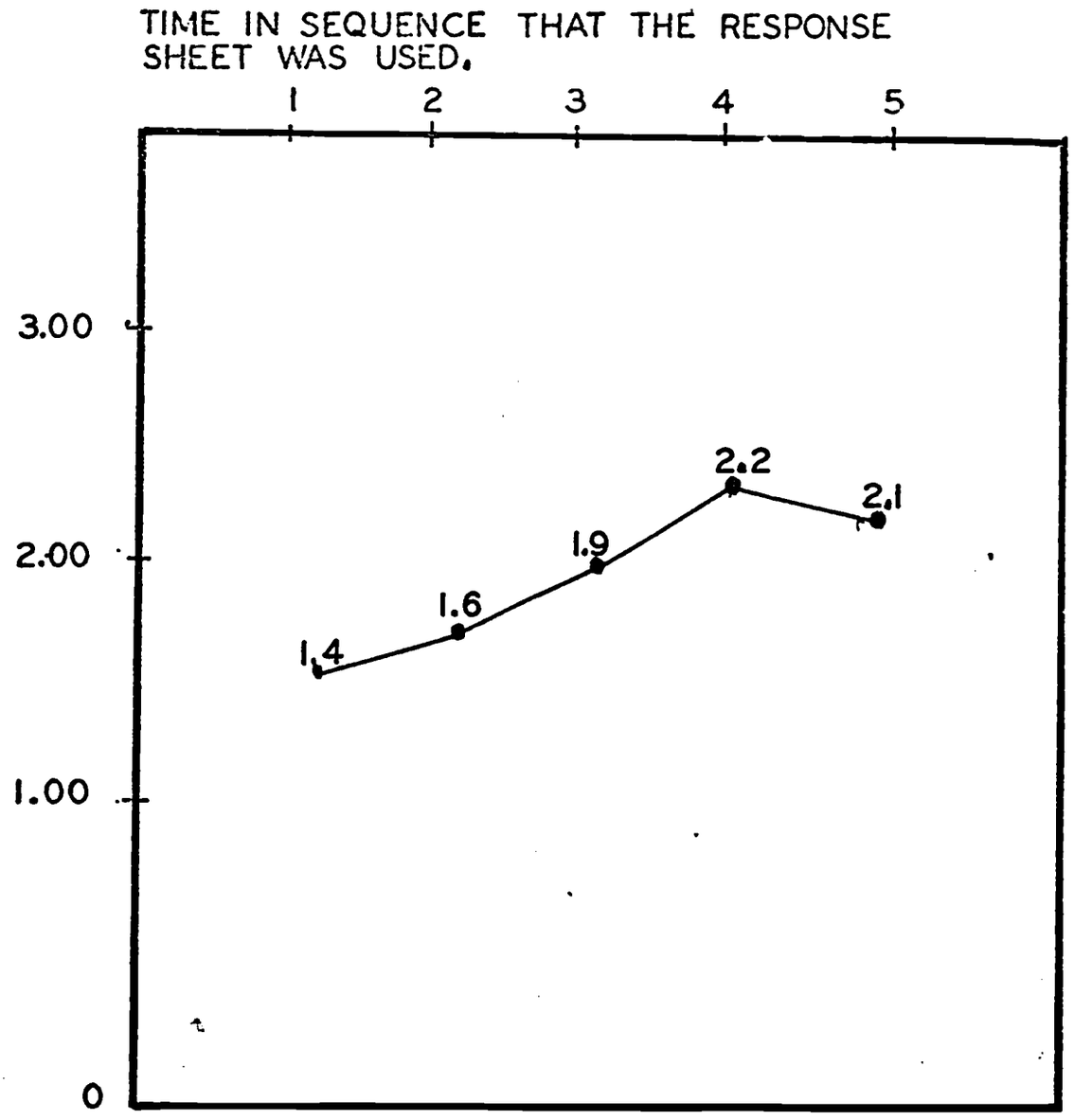

FIGURE XIII

OVERALL RATIO OF THE STUDENT RESPONSE OF INTERESTED OVER THE STUDENT RESPONSE OF BORED GIVEN TO TEACHERS DURING THE SEQUENCE OF RATING SHEETS GIVEN DURING THE TREATMENT MONTH.

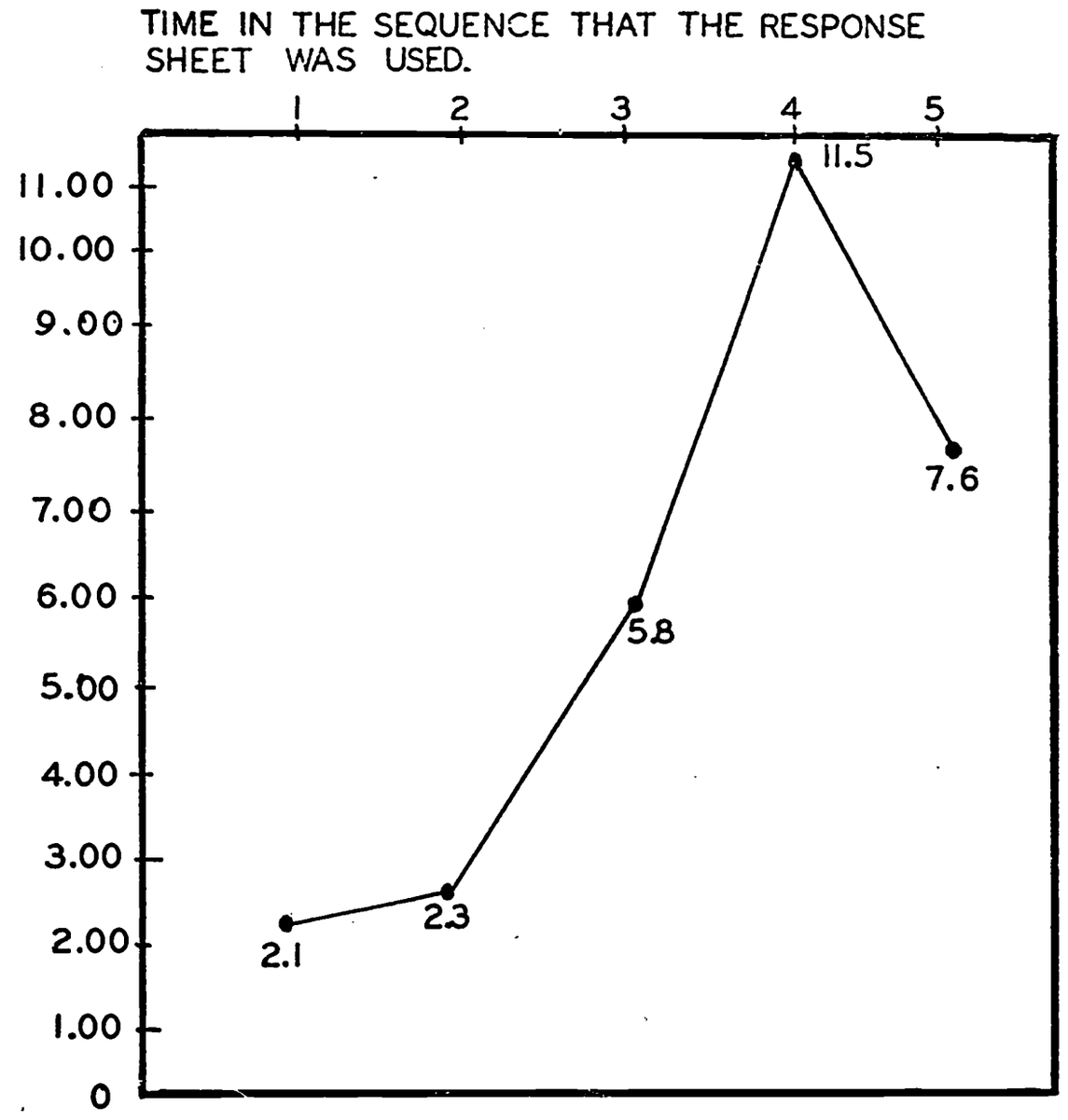

FIGURE XIV

OVERALL RATIO OF THE STUDENT RESPONSE OF UNDERSTAND OVER THE STUDENT RESPONSE OF DON'T UNDERSTAND GIVEN TO TEACHERS DURING THE SEQUENCE OF RATING SHEETS GIVEN DURING THE TREATMENT MONTH.

could only use the sheet five times. Therefore, for the sake of uniformity, only the first five sheets were used.

Finding 18

Finally it was decided that in order to justify the decision to use the middle thirty minutes of a lesson to correlate with student reactions during the same thirty minutes and to base most of the analysis on this same thirty minutes, a compilation of all the response sheets was in order. The time segments for all of the response sheets completed by the students during the study was computed, and the results are shown on Table 15. It will be noted that the middle thirty minutes show the greatest number of student responses. Figure XV further illustrates that either the students feel that the lesson only starts and ends during these thirty minutes, or that the first and last minutes of a lesson are taken up with non-academic behaviors. A perusal of the Parakh codes for these lessons substantiates this by showing a 10 to 15 minute segment at the beginnings and ends of each lesson taken up with strictly routine and non-academic matters.[1] It will also be noticed on Table 15 that the changes in each time segment for all but one category is statistically significant. This is indicative of students' reacting to their rating sheets in a non-random purposeful manner.

[1]Jal S. Parakh, "A Study of Teacher - Pupil Inter-Action in High School Biology Classes," Unpublished Doctoral Dissertation, Cornell University, Ithica, New York, 1965.

TABLE 15

CUMULATIVE FREQUENCIES AND PER CENT OF TOTAL PUPIL RESPONSES FOR ALL TEACHERS

Too Fast	Too Slow	Inter-ested	Bored	Under-stand	Don't Under-stand	Good	Per Cent Total	
111 18.07	179 23.03	822 16.28	531 18.54	821 15.30	180 16.49	742 16.65	3386 .167	First 10 min.
176 28.66	212 27.28	1332 26.38	726 25.35	1432 26.68	305 27.95	949 21.30	5130 .253	Second 10 min.
173 28.17	212 27.28	1460 28.91	768 26.82	1566 29.18	313 28.68	1251 28.08	5743 .284	Third 10 min.
98 15.96	132 16.99	1012 20.04	574 20.04	1097 20.44	200 18.33	1034 23.21	4141 .204	Fourth 10 min.
56 9.12	42 5.40	423 8.37	264 9.22	450 8.38	93 8.52	478 10.73	1806 .092	Fifth 10 min.
614	777	5049	2863	5366	1091	4454	20,214	TOTAL
122.8	155.4	1009.8	572.6	1073.2	218.2	890.8		$\div$ 5
14.83	16.86	13.457	9.6796	14.320	14.28	8.7269		Σ^2

X^2 significant at 5% = 9.488

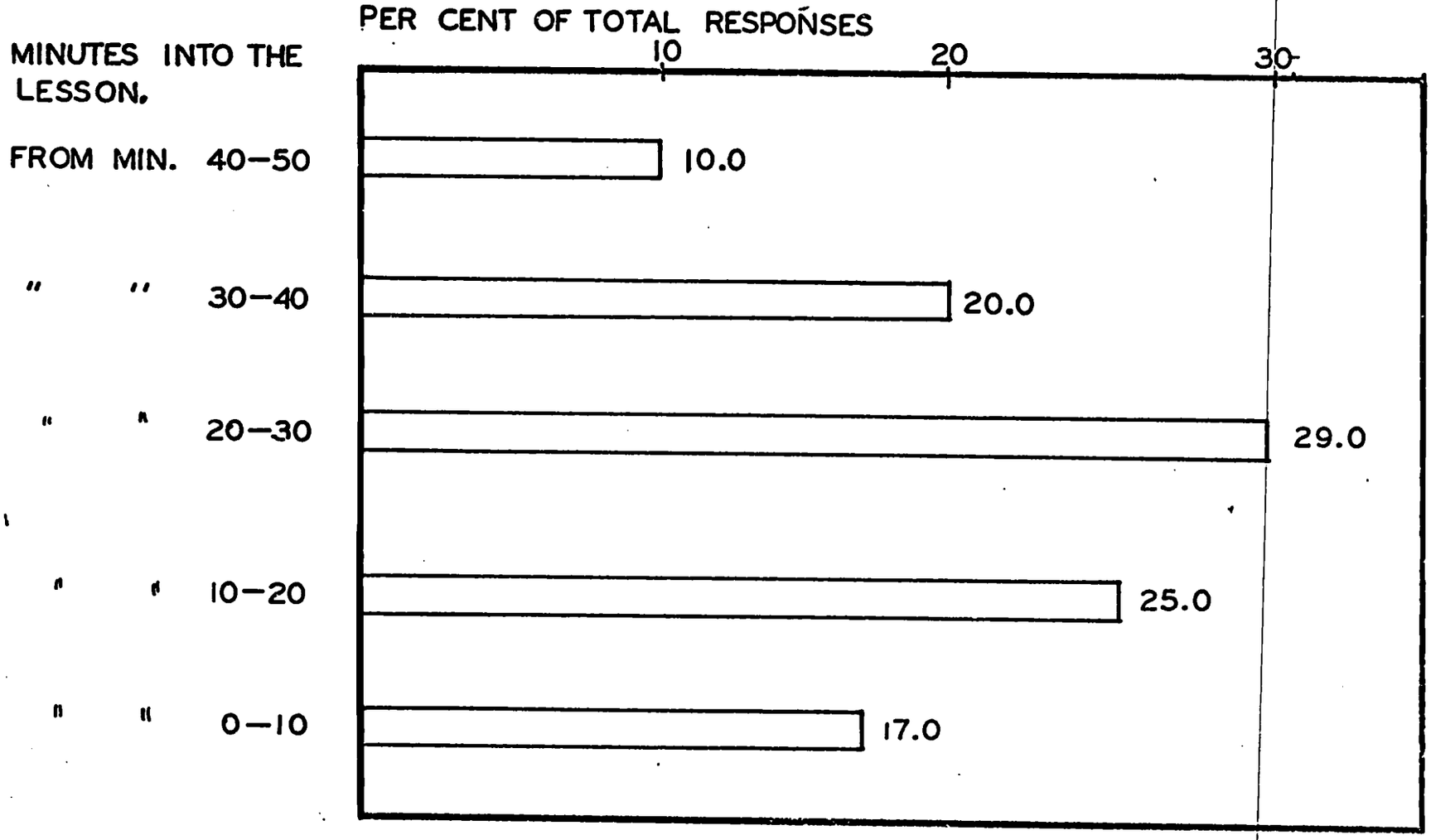

FIGURE XV

PERCENTAGE OF TOTAL RESPONSES MADE DURING ALL THE LESSONS FOR ALL THE TEACHERS.

Finding 19

It was further decided that a test for statistical significance of the student ratings of teachers over the period of the use of the rating sheet would further emphasize the significance of this change. Table 16 illustrates that with the exception of one category all of those tested were found to be significantly different and as pointed out in earlier figures, significantly different in a direction that could be defined as more positive in nature.

TABLE 16

CHI SQUARE TESTS OF SIGNIFICANCE OF CHANGE IN THE NUMBER OF RATINGS IN STUDENT RATING SHEETS

Time in Sequence	Frequency of Bored	Σ^2
1	606	51.67
2	485	2.2
3	405	5.0
4	378	12.4
5	393	7.94
TOTAL	2267	79.21

Time in Sequence	Frequency of Interested	Σ^2
1	840	1.7
2	831	.9
3	800	.01
4	749	3.6
5	797	.04
TOTAL	4017	6.25

Time in Sequence	Frequency of Understand	Σ^2
1	995	12.3
2	890	.00
3	882	.09
4	882	.09
5	809	7.54
TOTAL	4459	20.02

Time in Sequence	Frequency of Don't Understand	Σ^2
1	304	93.09
2	255	33.6
3	149	4.14
4	76	56.8
5	99	33.6
TOTAL	883	221.2

Time in Sequence	Frequency of Positive Feedback	Σ^2
1	2534	28.06
2	2203	2.66
3	2320	.66
4	2256	.27
5	2096	15.00
TOTAL	11409	46.65

Time in Sequence	Frequency of Negative Feedback	Σ^2
1	1237	157.4
2	959	11.89
3	747	14.36
4	626	62.73
5	721	21.87
TOTAL	4290	278.2

Chi Square needed for significance - 9.49

IV. SUMMARY AND RECOMMENDATIONS

What effects a timed feedback instrument had on the observed classroom behaviors of eighteen biological science teachers from four different high schools were studied and described during the 1971-1972 school year. One month prior to the use of the feedback instrument, audio tapes of the first group of teachers' verbal behavior during random classes were made. These tapes were analyzed in order to determine a base line of teaching behavior. The timed feedback instruments were used by the teachers in their classes during the second month, and again audio tapes were made and analyzed to see the affects the instrument would have. During the third month, when the instruments were no longer used, audio tapes were again made of classroom verbal behavior and then analyzed for permanancy of further change in verbal behavior patterns. A second and third group of teachers went through the same sequence of events in order to verify any change in behavior and to establish that change was not due to the time of year or section of the text covered.

The analysis of the audio tapes included the use of a modified version of Parakh's interaction analysis system.[1]

[1]Jal S. Parakh, "A Study of Teacher-Pupil Interaction in High School Biology Classes," Unpublished doctoral dissertation, Cornell University, Ithica, New York, 1965.

The Parakh was to determine any variations in the per cent of total class time spent with only the teacher talking. The Parakh also illustrated the sequence during the lesson of pupil and teacher statements. The monogram codes of the same Parakh analysis were placed in a six set matrix.[1] The matrix was used to determine the changes from month to month in the per cent of any particular teching mode. Finally the Kondo Questioning Categories System was used in order to determine the change in questioning behavior on the part of the teacher during and after the use of the feedback instrument in their classes.[2]

Finding 01 illustrates that the overall trend is toward less teacher-talk in the classes held during the month the rating sheets were used and the month immediately following the use of the instrument. As each group of teachers started at different times during the school year, the change cannot be simply dismissed as common to that part of the semester or that topic in a textbook. It is therefore reasonable to conclude that the student feedback devices were influencing the teachers.

Findings 02 and 03 are illustrative of the change in

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[1]Gene W. Moser and Roberta Feldgoise, "Project in the Use of Interaction Analysis to Increase the Use of the Inquiry Method in the Teaching of Science," Science Project Center Report, April, 1968.

[2]Alan K. Kondo, "The Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching," Presented at the NARST meeting, Pasadena, California, Feb. 7, 1969.

the teaching modes after the introduction of the rating device. Although finding 03 shows that the overall trend is toward less lecture and therefore more student involvement, a look at the summary data (see Appendix F) used for the measure of change in finding 03 shows that not all teachers moved toward a greater percentage of the teaching modes of discussion or transition. Nor is there any reason why they should. If the teachers were truly responding to the student feedback, then it is reasonable to assume that certain classes would find the lecture mode of teacher behavior, if not necessarily more enjoyable, more clear and less frustrating.

Findings 04, 06, and 07 may give us more insight into the reasons behind a teacher lecturing more or lecturing less. These findings point out that there is a definite correlation between the type of teaching mode and the percentage of student rating given at that same time for the categories of "Good" and "Understand". The findings show a negative correlation of the lecture mode with "Good" but a positive correlation of discussion and transition modes with "Good". However, the lecture mode is positively correlated with "Understand", while the discussion and transition modes are negatively correlated with "Understand". This then could explain why teachers who responded to the feedback could have gone in opposite directions. Students, while enjoying a lesson replete with student discussion and participation, might not understand the subject or feel that they have to understand it since only their peers are talking;

therefore they would not check the "Understand" category on their response instrument. However, these same students, while not feeling that the lecture mode was "Good" might understand more or be more aware that they should have checked "Understand" since the teacher, not their peers, is talking. Therefore, if a teacher examining the feedback sheets, concentrates on only positive feedback such as all of the student responses to "Understand" and ignores the lack of "Good" checkmarks, he could feel secure in his mode of teaching and perhaps intensify his performance in that same direction.

Finding 05 illustrates that the teachers in this study were seldom in the inquiry mode of teaching as defined by the six set.[1] Although it may be noted in the raw data in Table 6 that teachers did make some efforts to get into this mode, very few sustained their efforts long enough to have a significant outcome. It is obvious that more than student feedback will be needed in order to move teachers all the way from the lecture mode to more inquiry-oriented behaviors.

Findings 08, 09, 10, and 11 illustrate that some change was evidenced in questioning behavior. The change was not in the questioning techniques used, but only in the number of questions asked. The mean number of questions decreased as pointed out in finding 08. A reason for these

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[1]Moser, Op. Cit.

findings could be the lack of teacher technique in the area of asking questions that stimulate discussion. Great numbers of recall questions had an adverse affect on the students. A teacher trying to pace his lesson might ask more questions in order to make sure his students understand him. However, the only type of questions he feels comfortable with are short answer, recall type. The student responds to these negatively with comments on the feedback sheet like, "Do not grill us", "Too many questions", "Stop trying to embarrass us". Therefore the teacher stops asking questions, where at this point, had the teacher been simply given some guidance in other questioning techniques he may have been more successful.

It will be noted that the major differences in questioning behavior is among teachers and their classes. As pointed out in Findings 8 to 11, teacher questioning behavior showed statistically significant differences but student questioning over the combined three months of the study did not change significantly. However, there were differences among the classes of different teachers. It would seem that once a teaching pattern is established it can be affected by student feedback. However, something more is needed to increase and direct this new-found teacher awareness.

Finding 12 again shows that while some teachers did try to involve more students in less structured classroom environments, the majority stuck to their established routine. The ones who did respond to student ratings often reverted as soon as the ratings stopped. Others simply ignored en-

treaties such as "How come we never have labs". Most interesting were the teachers who began with high inquiry-oriented activities but after using the student reaction sheets switched to lesser amounts of inquiry-oriented classes. This too can be answered by the lack of checks on the instruments in the "Understand" and "Good" columns. This, coupled with the anecdotal comments such as "We are lost", "We have too many labs and not enough time", "You do not explain enough", perhaps gave the impetus for more non-inquiry oriented classes.

Once again the above results point out the need for teacher guidance in how to react to student needs once the needs are established. Regardless, the teachers did respond in the general direction, if not necessarily in the direction a science educator would expect, of the students' wants. This can be seen in Findings 14, 15, 16 and 17. A compilation of student ratings arranged sequentially (first time used, second time used, etc.) shows an overall trend of more positive student ratings. Teachers received greater numbers of "Interested" than "Bored" ratings, greater numbers of "Good" ratings, and most dramatically, a much greater proportion of "Understand" ratings to "Don't Understand" in later rating sheets. If the pupils were not using the rating sheets conscientiously, either day to day, or minute to minute, random results could be conjectured. Evidence does not support this conjecture. Finding 18 shows that there is a statistically significant difference over the five time periods during all the times the response instrument was used.

Further, finding 19 statistically tests what is pointed out graphically in findings 14 through 17. There is a statistically significant difference in ratings over the sequential periods of instrument usage.

Finding 13 shows the results of correlating student ratings on the Kochendorfer with the results of the six set.[1,2] Although these results are not statistically significant, the direction of the correlation does give us reasonable assurance of the conscientiousness and reliability of student ratings. Table 16 shows that those teachers who have a high per cent of the lecture mode receive a lower score on the Kochendorfer and those with a higher percentage of the inquiry mode receive higher scores on the Kochendorfer.

It can now be reasonably concluded that pupils can give effective timed feedback during a lesson and this feedback does effect change in the teaching behavior of their teachers. It is also apparent that in order to effect changes in the teacher or student teacher that lead to more effective teaching practices, the feedback instrument needs to be used in conjunction with guidance and training in these practices. Is there a way to train teachers to ask more thought-provoking questions so that when feedback from students is proferred, the overall reaction from the students will be a positive

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[1]Leonard H. Kochendorfer, "The Development of a Student Checklist to Determine Classroom Teaching Practices in High School Biology," University of Texas, Austin, Texas, 1969.

[2]Moser, Op. Cit.

one? Can we utilize the pupil awareness engendered in teachers by timed pupil feedback in order to direct the in-service or future teachers into more productive teaching? Can resources be made available to the teacher for the express purpose of providing him with alternate teaching strategies to improve the nature of the feedback and therefore his effectiveness in teaching? These questions should be and can be answered by utilizing the best resource in the classroom, the pupils.

APPENDICES

Appendix A

Student Response Instrument

Date_____

Too Fast / Too Slow	Understand / Don't Understand	Interested / Bored	Good	_____ Comments	time
Too Fast / Too Slow	Understand / Don't Understand	Interested / Bored	Good	_____ Comments	time
Too Fast / Too Slow	Understand / Don't Understand	Interested / Bored	Good	_____ Comments	time
Too Fast / Too Slow	Understand / Don't Understand	Interested / Bored	Good	_____ Comments	time
Too Fast / Too Slow	Understand / Don't Understand	Interested / Bored	Good	_____ Comments	time

Appendix B

Modified Parakh Interaction Analysis System*
Information Flow
(input-output)

Code of Terms

A. Classification of Pupil Behavior

1.01	Pupil asks question about definition (of terms, to give example of terms.)	PQD
1.02	Pupil asks question about facts (to describe, give an account of report or event.)	PQF
1.03	Pupil asks question about explanation (inferences, making comparisons, state relationships between objects, events; generalizations.)	PQX
1.04	Pupil asks question about value (judgments, opinions about subject matter.)	PQ Ev
1.05	Pupil asks question about nature of science	PQN
1.06	Pupil asks question about problem-solving (procedure, technique - steps to be taken to carry out experiment or to solve a problem that grows out of or is an extension of the "required" work.)	PQP
1.07	Pupil asks question about routines (assignments, procedures, materials, directions, techniques and classroom routines.)	PQR
1.08	Pupil asks question about lack of knowledge (lack of information or limitation of knowledge.)	PQL
2.01	Pupil responds to direct teacher question (requested) or (directed) to him. Definition	PRD
2.02	facts	PRF

*Modified and validated at the University of Pittsburgh

2.03	explanations	PRX
2.04	values	PR Ev
2.05	nature of science	PRN
2.06	problem-solving	PRP
2.07	routines	PRR
2.08	lack of knowledge	PRL
3.01	Pupil makes self-initiated statement about definition	PSD
3.02	facts	PSF
3.03	explanations	PSX
3.04	values	PS Ev
3.05	nature of science	PSN
3.06	problem-solving	PSP
3.07	routines	PSR
3.08	lack of knowledge	PSL
4.01	Pupil volunteers information (when teacher question is asked) about definition	PVD
4.02	facts	PVF
4.03	explanations	PVX
4.04	values	PV Ev
4.05	nature of science	PVN
4.06	problem-solving	PVP
4.07	routine	PVR
4.08	lack of knowledge	PVL
4.09	Pupil volunteers joke	PVJ
4.10	Pupil volunteers (writing on chalkboard)	PVW

B. Classification of Teacher Behavior
Teacher asks question about:

1.01	definition	TQD
1.02	facts	TQF
1.03	explanations	TQX
1.04	values	TQ Ev
1.05	nature of science	TQN
1.06	problem-solving	TQP
1.07	routines	TQR
1.08	lack of knowledge	TQL
2.01	Teacher lectures or states information about definition	TSD
2.02	facts	TSF
2.03	explanations	TSX
2.04	values	TS Ev
2.05	nature of science	TSN
2.06	problem-solving	TSP
2.07	routines	TSR
2.08	lack of knowledge	TSL
3.01	Teacher demonstrates Teacher gives demonstration of technique, process or phenomenon	TD
3.02	Teacher looks at, examines, checks pupils work.	TL
3.03	Teacher attends to routines, class management, distributes materials, prepares materials, takes attendance, marks papers; consults notes and references.	TR
3.04	Teacher encourages, jokes, reduces tension, accepts jestings.	TJ

3.05	Teacher qualifies or corrects pupils responses (volunteered, self-initiated responses)-teacher doesn't accept student responses.	TREP
3.06	Teacher accepts response (volunteered, self-initiated responses).	TA
3.07	Teacher reprimands or chastises student responses.	TC
3.08	Teacher writes on chalkboard	TW

C. Other

1.01	Pause in flow environment	P
1.02	Pupil writes on chalkboard	PW
1.03	Pupil jokes or acts to reduce tension	PJ

Appendix C

Outline of Procedures Followed During Entire Study

October

1. Nine teachers chosen (Group I, high schools A and B)
2. Background data taken.
3. Audio tapes taken of each teacher during designated class period(s).
4. Time questionnaire completed at the end of each week by teacher.
5. Three audio tapes chosen at random for each teacher.

November

1. Group I teachers explain rating device to pupils.
2. Teachers utilize rating device at least two times per week for first three weeks, and if needed, the fourth week.
3. Audio tapes taken of randomly selected classes.
4. Teachers complete time questionnaire at the end of each week.
5. Pupils complete Kochendorfer at the end of the fourth week.
6. Three audio tapes chosen at random for each teacher.

December

1. No rating device used by Group I teachers
2. Time questionnaire completed at the end of month.
3. Audio tapes taken and three chosen at random for each teacher.

January

1. Six teachers chosen (Group II, high school C)
2. Background data taken.
3. Audio tapes taken of each teacher during designated class period(s).
4. Time questionnaire completed at the end of each week by teacher.
5. Three audio tapes chosen at random for each teacher.

February

1. Group II teachers explain rating device to pupils.
2. Teachers utilize rating device at least two times per week for first three weeks and if needed, the fourth week.
3. Audio tapes taken of randomly selected classes.
4. Teachers complete ti e questionnaire at the end of each week.
5. Pupils complete Kochendorfer at the end of the fourth week.
6. Three audio tapes chosen at random for each teacher.

March

1. No rating device used by Group II
2. Time questionnaire completed at the end of month.
3. Audio tapes taken and three chosen at random for each teacher.

March

1. Three teachers chosen (Group III, high school D)
2. Background data taken.

3. Audio tapes taken of each teacher during designated class period(s).
4. Time questionnaire completed at the end of each week by teacher.
5. Three audio tapes chosen at random for each teacher.

April

1. Group III teachers explain rating device to pupils.
2. Teachers utilize rating device at least two times per week for first three weeks and, if needed, the fourth week.
3. Audio tapes taken of randomly selected classes.
4. Teacher completes time questionnaire at the end of each week.
5. Pupils complete Kochendorfer at the end of the fourth week.
6. Three audio tapes chosen at random for each teacher.

May

1. No rating device used by Group III teachers.
2. Time questionnaire completed at the end of month.
3. Audio tapes taken and three chosen at random for each teacher.

Appendix D

Science Classroom Activity Checklist

SAMPLE QUESTION

Checklist	Answer Sheet T	F
1. My teacher often takes class attendance.	1.( )	( )

If the statement describes what occurs in your classroom, blacken the space under the letter T (True) on answer sheet; if it does not, blacken in the space under the letter F (False).

REMEMBER:

1. The purpose of the checklist is to determine how well you know what is going on in your classroom.
2. Make no marks in this booklet.
3. All statements should be answered on the answer sheet by blackening in the space under the chosen response in pencil or ink.
4. Please do not write your name on this booklet or answer sheet.

SECTION A

1. Much of our class time is spent listening to our teacher tell us about biology.
2. My teacher doesn't like to admit his mistakes.
3. If there is a discussion among students, the teacher usually tells us who is right.
4. My teacher often repeats almost exactly what the textbook says.
5. My teacher often asks us to explain the meaning of certain things in the text.
6. My teacher shows us that biology has almost all of the answers to questions about living things.
7. My teacher asks questions that cause us to think about things that we have learned in other chapters.
8. My teacher often asks questions that cause us to think about the evidence that is behind statements that are made in the textbook.

SECTION B

1. My job is to copy down and memorize what the teacher tells us.
2. We students are often allowed time in class to talk among ourselves about ideas in biology.
3. Much of our class time is spent in answering orally or in writing questions that are written in the textbook or on study guides.
4. Classroom demonstrations are usually done by students rather than by the teacher.
5. My teacher often asks us to explain the meaning of certain things in the text.

6. If I don't agree with what my teacher says, he wants me to say so.
7. Most of the questions that we ask in class are to clear up what the teacher or text has told us.
8. We often talk about the kind of evidence that is behind a scientist's conclusion.

SECTION C

1. When reading the text, we are expected to learn most of the details that are stated there.
2. We frequently are required to write out definitions to word lists.
3. When reading the textbook, we are always expected to look for the main problems and for the evidence that supports them.
4. Our teacher has tried to teach us how to ask questions of the text.
5. The textbook and the teacher's notes are about the only sources of biological knowledge that are discussed in class.
6. We sometimes read the original writings of scientists.
7. We are seldom or never required to outline sections of the textbook.

SECTION D

1. Our tests include many questions based on things that we have learned in the laboratory.
2. Our tests often ask us to write out definitions of terms.
3. Our tests often ask us to relate things that we have learned at different times.
4. Our tests often ask us to figure out answers to new problems.
5. Our tests often give us new data and ask us to draw conclusions from these data.
6. Our tests often ask us to put labels on drawings.

SECTION E

1. My teacher usually tells us step-by-step what we are to do in the laboratory.
2. We spend some time before every laboratory in determining the purpose of the experiment.
3. We often cannot finish our experiments because it takes so long to gather equipment and prepare solutions.
4. The laboratory meets on a regularly scheduled basis (such as every Friday).
5. We often use the laboratory to investigate a problem that comes up in class.
6. The laboratory usually comes before we talk about the specific topic in class.
7. Often our laboratory work is not related to the topic that we are studying in class.
8. We usually know the answer to a laboratory problem that we are investigating before we begin the experiment.

SECTION F

1. Many of the experiments that are in the laboratory manual are done by the teacher or other students while the class watches.
2. The data that I collect are often different from data that are collected by the other students.
3. Our teacher is often busy grading papers or doing some other personal work while we are working in the laboratory.
4. During an experiment we record our data at the time we make our observations.
5. We are sometimes asked to design our own experiment to answer a question that puzzles us.
6. We often ask the teacher if we are doing the right thing in our experiments.
7. The teacher answers most of our questions about the laboratory work by asking us questions.
8. We spend less than one-fourth of our time in biology doing laboratory work.
9. We never have the chance to try our own ways of doing the laboratory work.

SECTION G

1. We talk about what we have observed in the laboratory within a day or two after every session.
2. After every laboratory session, we compare the data that we have collected with the data of other individuals or groups.
3. Our teacher often grades our data books for neatness.
4. We are required to copy the purpose, materials, and procedure used in our experiments from the laboratory manual.
5. We are allowed to go beyond the regular laboratory exercise and do some experimenting on our own.
6. We have a chance to analyze the conclusions that we have drawn in the laboratory.
7. The class is able to explain all unusual data that are collected in the laboratory.

Appendix E

Kondo Question Category System

Category	
R: Routine	Questions - Routine classroom matters: Management, Structuring class discussion, Approval or disapproval of an idea.
CM: Cognitive Memory	Simple recall of facts, formulas and other. Items of remembered content by recognition rote memory and selective recall. Questions ask for definitions, or recapitulation, or clarification or fact stating.
CC: Convergent	Involve the analysis and integration of given or remembered data. Leads to one expected response because of the tightly structured framework which limits it. May ask for translation, association, explanation or conclusion.
E: Evaluative	Deal with matters of value rather than matters of fact. Characterized by verbal performance by its judgmental character.
D: Divergent	Questions allow children to independently generate their own data, often taking a new direction or perspective. These may call for elaboration, divergent, association, implication or synthesis. Questions which lead to further

questions, which cause children to devise studies, and which are "open-ended" (many acceptable responses possible) were included in this category.

Appendix F

Mean Per Cent of Lecture, Discussion and Transition for Each Teacher

Teacher		Lecture	Discussion	Transition
1	Month 1	50%	23%	27%
	Month 2	38%	11%	51%
	Month 3	37%	25%	48%
2	Month 1	78%	3%	18%
	Month 2	40%	16%	43%
	Month 3	41%	13%	40%
3	Month 1	56%	11%	32%
	Month 2	60%	9%	31%
	Month 3	65%	3%	25%
4	Month 1	77%	2%	21%
	Month 2	56%	11%	33%
	Month 3	46%	15%	49%
5	Month 1	48%	12%	30%
	Month 2	51%	8%	41%
	Month 3	40%	16%	44%
6	Month 1	47%	9%	54%
	Month 2	28%	13%	69%
	Month 3	44%	15%	41%
7	Month 1	34%	13%	53%
	Month 2	35%	17%	58%

Teacher		Lecture	Discussion	Transition
	Month 3	25%	32%	43%
8	Month 1	59%	10%	32%
	Month 2	44%	10%	31%
	Month 3	49%	6%	37%
9	Month 1	66%	15%	29%
	Month 2	67%	5%	28%
	Month 3	30%	15%	51%
10	Month 1	71%	4%	25%
	Month 2	54%	8%	28%
	Month 3	71%	3%	26%
11	Month 1	51%	11%	38%
	Month 2	71%	21%	8%
	Month 3	34%	19%	47%
12	Month 1	83%	4%	13%
	Month 2	53%	15%	32%
	Month 3	30%	21%	49%
13	Month 1	64%	6%	30%
	Month 2	64%	4%	32%
	Month 3	43%	13%	44%
14	Month 1	62%	6%	32%
	Month 2	51%	13%	36%
	Month 3	35%	7%	68%

Teacher		Lecture	Discussion	Transition
15	Month 1	81%	8%	11%
	Month 2	71%	9%	20%
	Month 3	90%	10%	3%
16	Month 1	41%	28%	31%
	Month 2	46%	8%	46%
	Month 3	44%	13%	43%
17	Month 1	43%	12%	42%
	Month 2	76%	6%	18%
	Month 3	32%	9%	59%
18	Month 1	46%	10%	44%
	Month 2	28%	28%	54%
	Month 3	18%	34%	68%

Appendix G

Summary of Gallagher Aschner Totals for each Teacher

Teacher		R	CM	CC	D	E	T
1	Month 1	12	37	10	2	1	62
	Month 2	16	27	36	2	0	81
	Month 3	2	4	2	0	1	9
2	Month 1	11	10	2	1	0	24
	Month 2	7	60	16	0	0	83
	Month 3	11	81	16	3	0	111
3	Month 1	13	35	8	0	1	57
	Month 2	8	13	9	5	1	36
	Month 3	4	9	1	0	0	14
4	Month 1	14	9	6	8	0	31
	Month 2	16	12	20	7	0	55
	Month 3	11	13	24	11	1	60
5	Month 1	1	28	8	2	2	41
	Month 2	5	28	4	2	0	39
	Month 3	7	20	4	1	0	32
6	Month 1	25	36	12	2	0	75
	Month 2	27	3	28	0	2	60
	Month 3	6	16	8	2	0	32
7	Month 1	5	31	20	2	0	58
	Month 2	8	35	13	6	0	62
	Month 3	6	13	11	7	1	38
8	Month 1	8	76	25	1	0	119
	Month 2	7	15	3	0	1	26
	Month 3	5	28	4	1	0	38

Teacher		R	CM	CC	D	E	T
9	Month 1	10	53	9	0	0	82
	Month 2	7	62	25	0	1	95
	Month 3	8	19	9	3	2	41
10	Month 1	5	45	21	0	1	72
	Month 2	6	18	14	4	5	47
	Month 3	5	20	2	6	4	37
11	Month 1	2	70	14	2	12	100
	Month 2	4	36	7	2	0	49
	Month 3	16	16	55	4	0	91
12	Month 1	6	3	8	2	0	19
	Month 2	16	17	22	0	0	55
	Month 3	12	8	0	0	0	20
13	Month 1	2	60	20	2	0	84
	Month 2	4	37	9	0	1	52
	Month 3	1	26	11	3	0	41
14	Month 1	5	3	1	0	0	9
	Month 2	13	18	40	7	3	81
	Month 3	2	7	7	2	0	18
15	Month 1	11	35	10	0	0	56
	Month 2	5	24	16	0	0	45
	Month 3	8	09	7	0	0	24
16	Month 1	6	84	3	0	1	94
	Month 2	12	56	28	2	0	98
	Month 3	4	52	25	15	4	100
17	Month 1	1	7	3	1	1	13
	Month 2	1	4	4	1	0	10
	Month 3	1	13	0	0	0	14

Teacher		R	CM	CC	D	E	T
18	Month 1	13	3	11	2	0	29
	Month 2	17	2	0	0	0	19
	Month 3	5	0	0	0	0	5

Appendix H

Mean Per Cent Teacher Talk

Teacher	Month 1	Month 2	Month 3
1	93%	77%	83%
2	92%	83%	82%
3	83%	87%	82%
4	92%	86%	74%
5	85%	83%	83%
6	82%	70%	79%
7	81%	79%	72%
8	86%	73%	82%
9	85%	90%	78%
10	90%	80%	94%
11	81%	90%	76%
12	94%	95%	65%
13	89%	91%	83%
14	83%	81%	83%
15	94%	95%	97%
16	77%	83%	78%
17	83%	89%	90%
18	59%	66%	68%

Appendix I

Six Set Matrix

	6:0	5:1	4:2	3:3	2:4	1:5	0:6
6:0	A	B					
5:1	C	D					
4:2			E	F	G		
3:3			H	I	J		
2:4			K	L	M		
1:5						N	O
0:6						P	Q

A - D Defined as lecture

E - M Defined as discussion

N - Q Defined as inquiry

All others defined as transition.

A tally in square "A" is to be read as 6 teacher codes followed by 6 more teacher codes. A tally in square "F" would be read as 4 teacher - 2 student codes followed by 3 teacher - 3 student codes.

Appendix J

Sample Teacher Time Questionnaire

Lab.			Classroom			
	Ind.	Small Group		Ind.	Small Group	Entire Class
Same Lab	(A)	(C)	Teacher	(E)	(F)	(G)
Diff. Labs	(B)	(D)	Pupil	(H)	(I)	(J)
Other_____			Other_____			

Lab.			Classroom			
	Ind.	Small Group		Ind.	Small Group	Entire Class
Same Lab	25		Teacher		5	30
Diff. Labs		10	Pupil	25		
Other_____			Other_____			

Appendix K

Summary Table of Values for Main Observor Original Transcription Compared With a Later Transcription of the Same Audio Tape

Category	Per Cent of First Transcription	Per Cent of Second Transcription	Per Cent of Difference
TS	60	62	2
PS	16	16	0
TQ	4	5	1
PQ	5	6	1
TW	10	7	3
TJ	.6	--	.6
PV	.6	.7	.1
PJ	.2	.2	0
TA	.6	1	.4
PR	.6	0	.6
TC	0	.2	.2
Totals	100	100	9 per cent

$$\text{Reliability } (r) = \frac{P_o - P_e}{1.00 - P_e}$$

$P_o = 1 - .09$
$= .91$

$P_e = .60^2 + .16^2$
$= .3600 + .0256$
$= .3856$

$$r = \frac{.91 - .3856}{1 - .3856}$$

$r = .85*$

* = Intra-observer reliability coefficient 85%

Appendix K

Summary Table of Values for Main Observer's Transcription Compared with Independent Observer M's Transcription of the Same Audio Tape

Category	Per Cent of Main Observer	Per Cent of Observer M	Per Cent of Difference
TS	61	63	2
PR+PS	16.3	16	.3
TQ	4.5	5	.5
PQ	5.5	7	1.5
TW	8.5	7	1.5
TJ	.3	0	.3
PV	.6	1	.4
PJ	.2	.2	0
TA	.8	.2	.6
TC	.1	0	.1
Total	100	100	5.4

$$\text{Reliability } (r) = \frac{P_o - P_e}{1.00 - P_e}$$

$P_o = 1 - .054$
$= .946$

$P_e = .62^2 + .16^2$
$= .3977$

$$r = \frac{.946 - .3977}{1 - .3977}$$

$r = .90^*$

* = Inter-observer reliability coefficient 90%

Appendix K

Summary Table of Values for Main Observer's Transcription Compared with Independent Observer F's Transcription of Same Audio Tape

Category	Per Cent of Main Observer	Per Cent of Observer F	Per Cent of Difference
TS	.61	64	3
PS+PR	16.3	13	3.3
TQ	4.5	5	.5
PQ	5.5	5	.5
TW	8.5	8	.5
TJ	.3	0	.3
PV	.6	1.6	1.0
PJ	.2	.4	.2
TA	.8	1.0	.2
TC	.1	0	.1
Total	100	100	9.6

$$\text{Reliability } (r) = \frac{P_o - P_e}{1.00 - P_e}$$

$P_o = 1 - .096$
$= .904$

$P_e = .61^2 + .16^2$
$= .3977$

$$r = \frac{.904 - .3977}{1 - .3977}$$

$r = .84*$

* = Inter-observer reliability coefficient 84%

Appendix K

Summary Table of Values of the Transcription of Independent Observer F Compared with Independent Observer M of the Same Audio Tape

Category	Per Cent of Observer F	Per Cent of Observer M	Per Cent of Difference
TS	64	63	1
PR+PS	13	16	3
TQ	5	5	0
PQ	5	7	2
TW	8	7	1
TJ	0	0	0
PV	1.6	1	.6
PJ	.4	.2	.2
TA	1.0	.2	.8
TC	0	0	0
Total	100	100	8.6

$$\text{Reliability } (r) = \frac{P_o - P_e}{1.00 - P_e}$$

$P_o = 1-.086$
$= .914$

$P_e = .64^2 + .13^2$
$= .4265$

$r = \frac{.914 - .4265}{1-.4265}$

$r = .88*$

* = Inter-observer reliability coefficient 88%

Appendix L

Results of Correlations of Student Categories with Lesson Type All of Which Showed No Significant Correlation

Per Cent of Lesson Type X	Per Cent of Student Category Y	Mean Per Cent of $\bar{X}$	Mean Per Cent of $\bar{Y}$	Mean Per Cent of rxy
Transition	Too Fast	.378	.030	-.050
Transition	Too Slow	.378	.051	-.010
Transition	Don't Understand	.378	.053	-.147
Transition	Bored	.378	.150	-.190
Transition	Interested	.378	.243	+.210
Lecture	Too Fast	.471	.030	+.056
Lecture	Too Slow	.471	.051	-.0073
Lecture	Don't Understand	.471	.053	-.0578
Lecture	Bored	.471	.150	+.0448
Lecture	Interested	.471	.243	-.088
Discussion	Too Fast	.153	.030	-.010
Discussion	Too Slow	.153	.051	-.060
Discussion	Don't Understand	.153	.053	+.009
Discussion	Bored	.153	.150	+.054
Discussion	Interested	.153	.243	-.090

Appendix M

Summary Table of Values for Main Observer Original Transcription Compared With a Later Transcription of the Same Audio Tape

Category	Per Cent of First Transcription	Per Cent of Second Transcription	Per Cent of Difference
R	8	7	1
CM	80	80	0
CC	12	13	1
D	0	0	0
E	0	0	0
Totals	100	100	2

Reliability (r) = $\frac{P_o - P_e}{1.00 - P_e}$ $\quad r = \frac{.98 - .65}{1 - .65}$

$P_o = 1.00 - .02$
$= .98$

$P_e = .64 + .01$
$= .65$

$= .94*$

* = Intra-observer reliability coefficient 94%

Appendix M

Summary Table of Values for Main Observer's Transcription Compared with Independent Observer D's Transcription of the Same Audio Tape

Category	Per Cent of Main Observer	Per Cent of Observer D	Per Cent of Difference
R	8	3	5
CM	80	86	6
CC	12	11	1
D	0	0	0
E	0	0	0
Total			12

Reliability (r) = $\frac{P_o - P_e}{1.00 - P_e}$ $\quad r = \frac{.88 - .65}{.35}$

$P_o = 1 - .12$
$= .88$

$r = .65$*

$P_e = .65$

* = Inter-observer reliability coefficient 65%

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